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Experience antithesis in Nobel Prize lectures

Enhancing understanding of molecular biology
by means of active, spatial antitheses?

One Year Master Thesis, Spring 2015
Rhetoric
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Abstract

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Content: This qualitative study explores whether antithesis, as a didactic rhetorical tool, may enhance the likelihood of understanding complex biology-related information. Research shows that students lack the ability of communicating expert knowledge to laymen since they do not understand subject matter well enough themselves due to scientific language. Hence, scientific language use should be studied in order to be altered, upon which students may understand subject matter more efficiently, and consequently become better at popular science communication. Antithesis is studied in Nobel Prize lectures, and it is questioned whether it may be interrelated with understanding in relation to theories on antithesis and partly spatial bodily experience in correlation to understanding. Close textual analysis and comparative stylistic analysis were employed as methods when analyzing antithesis content. Results show that contradictory and contrary oppositions may enhance understanding since they make subject matter easier to relate to by means of clarity and contrast.

Key words: Stylistic analysis, Rhetoric, Science Education, Antithesis, Understanding, Bodily Experience, Active processing, Nobel Prize lectures

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“We cannot solve our problems with the same thinking
we used when we created them”.

Albert Einstein

1. Introduction: The significance of antithesis

Is it possible to understand the meaning of UP[1] without its opposite DOWN? Can you ENTER and LEAVE a store without PULLING or PUSHING the door? Is it possible to discuss DNA replication without using the opposites 5'-END and 3'-END? How well would the characteristics of a CANCERCELL be understood without being able to contrast it to an ORDINARY CELL? And if viruses were not ENEMIES to the body's own ALLIED CELLS – what would they be?

The focus of this thesis is *antithesis* (Gk. *Anti* "against" and *thesis* "a setting" or *tithenai* "to set, place") and its possible correlation to understanding.[2] It shall be explored whether antithesis could influence language use, if and perhaps how it could contribute to a more efficient understanding of complex information, such as biology-related subject matter.

Antithesis concerns opposites and contrasts, comprising two cola, which are put in an opposing manner. Thus, the antithesis would have to meet both semantic and syntactic elements. This was however lost in history, and the structure of antithesis got a more loose definition.[3] I will however focus on the original definition of antithesis, where Lausberg's definition of antithesis, makes a great start: Antithesis is "the opposition of two *res* of contrasting content. The opposite *res* may be expressed in speech by means of single words, word groups or sentences".[4]

This rhetorical device is everywhere in everyday life and consequently in biology as well. It defines what A is and what A is not. This might seem trivial but from a rhetorical perspective, it is not always obvious what 'NOT A' is.[5] Seemingly, antithesis seems much needed when trying to understand and relate to the world since it is always necessary to contrast things from each other. Metaphors are suggested to be fundamental in language and hence to understanding [6] – what if antitheses are too? If so, could antitheses be used in order to alter the way we think? Could they aid understanding?

1.1. Rhetoric, language and rhetorical figures

The field of rhetorical studies concerns language from a pragmatic perspective and rests on the most fundamental rhetorical axiom: We choose language. Hence the focus lies outside of language, namely, on our choices of words and what consequences arise from using them.

[1] When I refer to antithesis I will generally use Lakoff and Johnson's (2003 [1980]) notation, in which metaphors are stated in small capitals.
[2] Lanham (1991:16)
[3] Enos (2001:19), Fahnestock (1999: 46, 54), Jasinski (2001:544-45), Mayoral (2001:27-28)
[4] Lausberg (1998: §787)
[5] Eriksson (2002: 350)
[6] Lakoff & Johnson (2003 [1980])

Rhetoric also provides a meta-reflexive vocabulary – tools which make it possible to discuss different perspectives of language and its many different structures and dimensions.[7] A domain within this vocabulary is the rhetorical figures, which are linguistic turns with such characteristic features that they can be named and arranged as groups. There is extensive research upon this matter which reaches as far back in time as to Quintilian, who is mostly associated with the categorization of rhetorical figures.[8] Today, however, one of the renowned researchers in the field is Jeanne Fahnestock. She has concluded that, among many rhetorical figures, antithesis is by far one of the most used rhetorical figures and seems as common as metaphors, and should be further researched.[9]Antithesis deals with opposition and contrast, as mentioned above, and can be interpreted as having comparison as an umbrella term. Among antithesis, there are many subgroups, which will be further explained in the first section of 2. Theoretical perspectives, as will rhetorical figures, antithesis and its relation to comparison. Below, I will discuss why antithesis is such an interesting topic and why I believe that it should be studied in relation to understanding.

1.2. The research gap – antithesis as a didactic device?

The original educational background of mine lies within the natural sciences. My bachelor's degrees in molecular biology as well as in rhetorical studies, allow me to explore whether antitheses can be found in the small world of biology and what they may be doing to it. What combines these two, otherwise quite distinct disciplines, is scientific communication. Herein lies my passion, namely how language can be used as a didactic tool in order to understand complex information more efficiently.

Research has revealed a lack in the ability to write and communicate expert knowledge to laymen among students in biology and molecular biology.[10] The problem is that the students do not seem to understand their subject matter well enough, which might have been caused by the dominance of scientific language in science education.[11] One only understands subject matter as long as one knows the language, and therefore scientific language is considered to be an answer to why students have difficulties learning science. [12] As a result, this has a negative influence on how well students communicate subject matter to a non-specialist audience because if they do not understand the topic well enough themselves it will probably be difficult to explain to laymen. Thus, language and how language is being used is

[7] Sigrell (2009:24), Sigrell (2008:206), Sigrell (2006:5)
[8] Fahnestock (1999:8-9,15)
[9] Ibid. (1999:13-14)
[10] Gadamer, Weinsheimer & Marshall (2004:386-87), Pelger, Santesson & Josefsson, G. (2009)
[11] Ibid.
[12] Ibid., Nilsson (2012:84)

an issue of great significance in science education. If there is a possibility of changing the way students use language in order for them to understand their subject matter more efficiently, it should be explored. This accounts for a change of language on a word level since it is ultimately the words, which together, are meaning-making. Such a word could be antithesis. [13]

In my interdisciplinary bachelor's thesis, I tried to tackle this problem, by analyzing whether conceptual metaphors could be found in student-written popular science articles and whether they may contribute to a more efficient understanding.[14] This idea was founded on the cognitive linguists', Lakoff and Johnson, theory – that the structure of language is fundamentally grounded on conceptual metaphors, presented in *Metaphors We Live By* (2003 [1980]). However, Lakoff and Johnson were not the first to study the structure of language and how it *may* be related to mind and reason. In one of my master's courses, I came across Alexander Bain (1818-1903) who made me wonder "what if there is more to Lakoff and Johnson's hypothesis?".

It is important to remember that language is only a straitjacket if we allow it to be. [15] Your way of using language (in order to think, read, talk and interpret) might already have become imprisoned by it. Language is arbitrary – every word has connotations, depending on *your* experiences. We use language unconsciously and become used to our ways of thinking, which, in the end, are difficult to break loose from. Although Lakoff and Johnson's theory on human reasoning is still a hypothesis, it is broadly accepted and we seem to have become used to they way of thinking that language and mind are conceptual metaphorical. But is metaphor the only fundamental structure? Metaphors may be fundamental – now one only has to believe that mind and reason exploits more than metaphors to start seeing new fundamental figures that lie at the heart of language.[16] Let go of the straitjacket.

Bain was a Scottish philosopher and educationalist, who studied rhetoric from a psychological perspective and claimed that the human understanding is fundamentally grounded on three chief mental operations: "DISCRIMINATION, or Feeling of Difference, Contrast, Relativity", "SIMILARITY, or the Feeling of Agreement", and "RETENTIVENESS, or Acquisition". Bain claims that the mind is affected by change and contrast, impressed by similarity, and makes connections and associations among domains that often are co-present or which seem to come in pairs. These chief mental operations are also called *antithesis*, *metaphor*, and *metonymy*, respectively. Among these, Bain states that antithesis is the most

[13] Richards (1976:47-48,57,70)
[14] Fredriksson (2013)
[15] Leech (1974:35)
[16] Fahnestock (2004:24)

crucial mental operation for understanding.[17] Let us assume that Lakoff and Johnson's hypothesis is a possible way for the brain to process information, a process important for understanding. What if antithesis is as fundamental as conceptual metaphors?

Apart from Lakoff and Johnson's metaphor theory, they also claim the mind to be embodied, by which they mean that anything understood is based on bodily experience. Therefore the most fundamental conceptual metaphors are the spatial, concepts which help us to orient ourselves in space. Interestingly, many of these seem antithetical: UP/DOWN, IN/OUT and NEAR/FAR, for instance.[18] This is why antithesis is such an intriguing rhetorical figure and deserves to be further researched; not only because this is a research gap within the rhetorical field (if and how antithesis might be related to understanding), but because if there are ways of using this rhetorical figure in a constructive manner, it would perhaps help students understand subject matter more efficiently.

1.3. Purpose and research questions

This study explores antithetical elements since they are claimed to be one of the most common elements in language and also since they might be correlated to understanding and conceptual thinking.[19] Inspired by the theories of Aristotle, Bain, Fahnestock and Lakoff and Johnson, my overarching research question (which cannot receive a 'full' answer here) relates to whether antithesis, as a rhetorical tool, may generate a more efficient understanding of abstract information – both to the sender as well as to the receiver – while communicating science. The purpose of this study is twofold. First I will present most of the antitheses found in one recent Nobel Prize lecture, categorize them (and compare it to nine others) in Physiology and Medicine (dealing with molecular biology). Then, I will make an attempt to analyze and explore whether antithesis somehow could potentially help the understanding of molecular biological information.

Although the Nobel Prize laureates use quite complex terms and talk about their research fields in both metaphors and similes, as well as quite complex terms at times, this language could still be considered to be popular science language – since "on any given scientific issue, a multitude of degrees and kinds of expertise".[20] Moreover, this language use (a mix of scientific and nonscientific terms) is often encountered in course literature which

[17] Bain (1908:135-36,196,260)
[18] Lakoff & Johnson (1999)
[19] Bain (1908), Paradis & Willners (2011:367,369-72)
[20] Perrault (2013: xiii)

students are exposed to – most authors are scientists[21], and need to communicate in such ways as Nobel Prize laureates do in the empirical data. Hence, the language used in the lectures are similar to the scientific language that students' encounter in the course literature which is why this is a suitable empirical data to study with regard to purpose and research questions.

Bain's theory on the interrelation between antithesis and understanding, together with the spatial, conceptual metaphors, makes an interesting combination; *if* antithesis could be related to understanding, and *if* understanding may be enhanced when using spatial relations, antithesis might be actively utilized accordingly in order to make understanding more efficient. In order to approach an answer to the overarching question above, the following question was asked while analyzing the lectures: **In what ways is antithesis found in the empirical data and how may antithesis be correlated to understanding?** To make that question operationalizable, I will try to answer the following subordinate questions:

- What antitheses[22] are there in the empirical data?
- How can they be categorized, both as opposites as well as with regard to spatial concepts?
- What consequences could arise from the presences of antitheses in the lectures, regarding the understanding of molecular biology subject matter?

1.4. Previous research: Cognitive rhetoric and rhetorical didactics

Since the present study involves a rhetorical didactic perspective on antithesis and understanding, the field of rhetorical didactics as well as cognitive rhetoric should be mentioned. The field of rhetorical didactics has recently started expanding in Scandinavia and focuses on implementing both rhetorical practice and theory in the educational system. The theories and practices are based on the rhetorical traditions but strive to develop and pursue more nuanced rhetorical theories and practices.[23] The field of cognitive rhetoric is also quite new and has emerged from different disciplines within the cognitive sciences, such as behaviorism, neurolinguistics and psychology. The goal is to understand the brain and mind, and if researchers are successful, this should result in a better understanding of language. That in turn "should lead to a better explanation of effective language, of persuasion, and hence of the complex behaviors and historical processes, mediated by language, that rhetoricians study".[24]

There has not been much research on antithesis in cognitive rhetoric, however there has

[21] For instance the following, well known researchers writes course literature and teach students: Robert Weinberg – *The Biology of Cancer* (2014), Bruce Albert – *Molecular Biology of the Cell* (2005) and Kenneth Murphy et al. – *Janeway's immunobiology* (2008).
[22] Presented in Table A on page 13.
[23] Matthiesen (2013:4-5), Pelger & Sigrell (2015, in press)
[24] Fahnestock (2005:160-61)

been more research on antithesis. Fahnestock, as already mentioned, has studied rhetorical figures and has concluded that, among many, antithesis is by far the most used rhetorical figure, at least within the natural sciences. When an article is rewritten to fit a different purpose or a different audience, it is the antithesis that invariably remains and occurs in the new versions of the very same original. [25] Moreover, she writes that both Bacon and Darwin transformed antithesis into a scientific method and a way of direct inquiry. Antithesis thus helped them guiding their way of thinking and discovering new material as well.[26]

Randy Harris, professor in rhetoric at Waterloo University, Canada, proposes that antithesis should be regarded as the fourth master trope instead of irony, since irony is based on contraries in the sense that what is explicitly said is not what is meant (an opposition) – hence irony is a subgroup to antithesis.[27] Moreover, irony is neither semantic nor cognitive, as are the other three master tropes (metaphor, metonymy, synecdoche), but is more of an attitude. Additionally, irony does not imply "'a change in a word' from its proper signification" which a trope should.[28] But what does a change from 'proper signification' mean? This expression calls for a discussion regarding rhetorical figures and their correlation to language as well as *ordo naturalis* and *ordo artificialis*. 'Naturalis' implies what is the most common way of phrasing something in a particular context (obviously, what is 'natural' depends on perspective) – 'what seems more natural' – hence, it does not make claims on a one-to-one-relationship between words and what the words denotes. 'Artificialis' on the other hand implies an expression which has been actively altered, something which seems different from the common phrasing.[29] The difference between these two rests on the idea that there are natural phrases to each and every context: "Where the line is drawn between the two principles of *ordo* depends on what order one considers as given by nature".[30] Returning to Harris, what he might be meaning with the expression could both concern *ordo naturalis* and *artificialis*. Anyhow, Harris emphasizes his point by presenting many definitions of irony and by citing Rice and Schofer who

> define *irony* as 'a relationship of opposition made possible by the identity of one or more semantic features, *and* the presence of one or more contrary semantic features'. That's not a definition of *irony*. That's a definition of *antithesis*.[31]

[25] Fahnestock (2004), Fahnestock (1999:13-14)
[26] Fahnestock (1999:59-60, 65)
[27] Harris (2013:1-3)
[28] Ibid. (2013:6)
[29] Lausberg § 447-48+52, 951, see also Kjeldsen (2008:208f)
[30] Ibid § 446
[31] Harris (2013:9)

Harris argues that the common denominator among the four master tropes, if antithesis is the fourth, is cognition. Metaphor is founded on similarity, metonymy on association, synecdoche on meronymy and antithesis on opposition – four operations of the mind that comprise mental abilities related to such processes as memory and comprehending the world as well as grasping information.[32] Thus, it is not only Bain who claims that thinking and understanding depend on contrasts and oppositions. Contrasts seem to be embodied in language. Contrasts seem to embody the mind.[33]

Although this study cannot make claims on whether spatiality and understanding are interrelated, it still seems necessary to mentioned a few studies where this interrelation seems likely. There has been some research apart from Lakoff and Johnson's. In *The Development of Spatial Cognition*, an anthology where the contributors share several arguments for the importance of spatial cognition when understanding the world.[34] Gärdenfors discusses partly the relation between how we orient ourselves in space in correlation to understanding and argue that spatiality is an important part for grasping the world – not that they depict "the real world", but that the concept "represent our understanding of how we perceive in our inner world".[35]

The present study distinguishes itself from previous ones, studying antithesis, in the sense that it is not so much concerned with antithesis on a lexical or semantic level, but approaches antithesis from a pragmatic point of view and in relation to understanding of complex information among students. What are antitheses doing to us and what are we doing with them that we might yet not know? What consequences arise from the use of antitheses in language? If we are aware of them, how can they be used in order to alter the way language is being used to better understand how we communicate, both as senders and as receivers?

[32] Evans (2007:17), Ibid. (2013:9)
[33] Lakoff & Johnson (1999), Paradis & Willners (2011:372)
[34] Cohen (1985)
[35] Gärdenfors (2014:11-12)

2. Theoretical perspectives

Due the chosen thesis topic, the purpose of the study and research questions, the theoretical framework comprises, apart from antithesis, a few perspectives on understanding, and a possible correlation between antithesis and understanding. The first and second sections discuss the history of rhetorical figures, antithesis and how antithesis can be categorized. The third section discusses the notion 'understanding' and 'the embodied mind' in relation to antithesis, and finally, it is described how the theories presented are to be used in the analysis.

2.1. Rhetorical figures – what are they?

Stylistics has its roots in ancient Greece, which belongs to *elocutio,* one of the canons of the rhetorical curriculum.[36] *Elocutio* focuses on expression and choice of words, on rhetorical style, as well as rhetorical figures. These rhetorical devices have almost, invariably, been regarded as ornaments and linguistic features which were to embellish language and emphasize arguments, and thus were not elements of 'ordinary language'.[37] Quintilian and his work, *Institutio Oratoria*, has gained much influence on how the rhetorical figures are to be perceived. Rhetorical figures are divided into either figures or tropes: Figures transform and rearrange the textual elements of a text (like anaphor) whereas tropes are substitutions of words, taken from the context in which they are usually found, and put in another so that they present a nuanced meaning (like metaphor).[38] The dichotomous categorization of rhetorical figures has been "repeated, refracted, and enriched", and has, in spite of all years that have passed, remained the same.[39]

2.1.1. Antithesis: As rhetorical device and pragmatic tool

Fahnestock defines antithesis as a scheme of parallel construction, constructed by cola, comprising a juxtaposition of contrasted or opposed terms, [40] and according to Lausberg (as mentioned in the introduction) antithesis is "the opposition of two *res* of contrasting content. The opposite *res* may be expressed in speech by means of single words, word groups or sentences".[41] Antithesis concerns apart from affirmation, negation, and according to Burke and Spinoza, Fahnestock and Aristotle, when defining what something is, one is simultaneously defining what something is not, i.e. one is describing the contrast, which without one could not define anything. 'To define' thus means to place what is to be defined

[36] Fahnestock (1999:6ff)
[37] Kjeldsen (2008:208)
[38] Fahnestock (2011:6-7), Fahnestock (1999:6ff, 53f), Hellspong (2011:113,143-44), Ibid. (2008:39,208)
[39] Fahnestock (1999:8-9,15), Kjeldsen (2008:208), Klujeff (2007:33)
[40] Aristotle, *Categories*, 11b17 to 14a19, Eriksson (2002: 337-338), Fahnestock (1999:46), Mayoral 2001:27-28
[41] Lausberg (1998: §787)

in terms of something else – an antithesis states what something is not; it presents A and (often but not always) it also presents NOT A.[42] Thus, antithesis concerns a difference to a similarity, a "genus", between two objects. This will be further discussed below.

Quintilian regarded antithesis first and foremost as a figure but suggested that it could be used as both a stylistic tool and an argument. By contrast, Aristotle claimed the antithesis to be, not only a stylistic device, but an effective device in argumentation as well.[43] Meanwhile, there are those who, today, disagree with Quintilian, such as Lanham, who suggests that a rhetorical figure (e.g. antithesis) might be both trope and figure depending on how it is approached, and both Aristotle and Fahnestock seem to agree.[44] Antithesis partly rearranges *res* (which could be *verba*) and makes it appear in a certain way but at the same time, it could present a nuanced meaning of *res*. Hence, antithesis may not only deal with *res* and how it is being presented, but also change the way *res* is being presented. Consequently, it seems reasonable to assume that antithesis both belongs to *artificialis* and *naturalis*. It could be used actively, but it may also be used in everyday language and hence be regarded as 'natural'. For instance, scientific language involves both *ordo naturalis* and *artificialis* – and this makes another argument for using Nobel Prize lectures as empirical data for the study.

In history, rhetorical figures have mostly been considered to belong to *elocutio*, as previously mentioned. Today, however, some rhetorical figures are not only considered a part of *elocutio* but *inventio* as well since a figure may have an argumentative influence, depending on how it is being used. Rhetorical devices may thus deal with both *res* and *verba*. In the case of antithesis, for instance, it can be very forceful to say what 'something' is in terms of what 'something' is not with a parallel structure. Since antithesis presents and transforms *res* and *verba* in a certain way, that may affect the appearance of *res*, antithesis could be both a figure and a trope, belonging to both *elocutio* and *inventio*, as pointed out above. [45] When realizing that rhetorical figures can be both a way of playing with words and structure, they may also introduce new perspectives on arguments in various communicative events. For instance, Darwin had a antithesis principle where the antithetical behavior of dog was described by antithesis, which he coined "the principle of antithesis".[46] In summary, when realizing rhetorical figures we may see perspectives that otherwise would have risked go missing. This implies that if rhetorical figures were to be interpreted differently they could maybe reveal new perspectives on language. Antithesis has always been regarded as a figure

[42] Burke (1945:24-25,143), Eriksson (2002: 338)
[43] Aristotle, *On Rhetoric*, 1404b, Kennedy [Aristotle] (2007:222)
[44] Lanham (1991:154-157), Fahnestock (1999:46, 54)
[45] Fahnestock (1999: 52-53, 58)
[46] Ibid. (1999: 65-67)

but what if it was to belong among the tropes as Harris suggests? Put in perspective, the difference between the dominating rhetoricians through history and the modern rhetoricians today, is that the focus has shifted from what a rhetorical figure *is* to what it *does*.[47] What is antithesis doing to a text?

Almost all words seem to call forth their opposites, and almost all words become conceptualized – not only what they do mean but also what they do not mean. Therefore, knowing the opposite of any word or concept might enhance the understanding of that specific word or concept. According to a commonplace in psychology, antitheses are better recognized when placed side by side, because they seem more evident, and consequently the mind realizes the difference in a more efficient manner.[48] As stated elsewhere, it is not always easy to know A/NOT A, and by having both in a parallel structure might make the information easier to grasp owing to the clarifying character of antithesis: ”Their contrary nature excludes qualities inherent in the one from the qualities inherent in the other”.[49] When both elements are present, the distinction between them becomes more prominent, and since NOT A is arbitrary, the receiver does not have to guess the NOT A.[50]

Moreover, the parallelism that cola brings is believed to produce “greater symmetry” which might be one of the factors to why the receiver’s “sense of the tightness or completeness” increases, who thereby perhaps grasps the information the antithesis provides more easily, since the receiver, due to symmetry, is more likely to remember the provided information. Without the cola, the antithesis appears not as strikingly heightening. The cola, together with the word pairs, is what makes antithesis a powerful tool in formulating arguments.[51] Sometimes, the A/NOT A is obvious by context and hence the antithesis might only entail one antithetical element. If the antithesis entails a pair of elements that already exists and is broadly accepted, “it is possible to use what could be only half an antithesis and still secure the effect of a whole”. It obviously depends on context and how well the receiver is familiar with the content that the antithesis presents.[52]

2.1.2. Comparison – umbrella term to antithesis

Comparison seems to be the mother of master tropes.[53] The master tropes, metaphor, metonymy and synecdoche, all comprise some kind of comparison, and so does antithesis.

[47] Fahnestock (1999:17,40), Klujeff (2008:30,36), Sigrell (2014:119)
[48] Fahnestock (1999:50), see also Eriksson (2002: 351), Jones (2002:169)
[49] Eriksson (2002: 341)
[50] Ibid. (2002: 339, 345, 347-48, 353)
[51] Fahnestock (1999: 49-51)
[52] Ibid. (1999:59)
[53] cf. pages 5-6. Note that irony is not included here.

The metaphor compares two different objects from different, unrelated domains, metonymy compares two, closely related objects, and the synecdoche concerns the comparison between parts and their wholes. These three comparison rest on different domains which somehow are similar.[54] Opposition, comprising the essence of antithesis, is a contradictory construct of comparison, which concerns (only what seem to be) differences. Thus, comparison is what connects the master tropes and is therefore the umbrella term. However, according to Spinoza and Burke, whenever antitheses are created or recognized, the process of comparison has taken place, which will not only elicit the differences but the similarities between the objects too, otherwise the process of discrimination cannot take place.[55] Without knowing what characteristics the objects share, it would probably not be possible to point out how they are different. When two objects are compared or contrasted, with respect to their lack of one or more properties, this is accomplished on the basis of the objects' similarities, e.g. genus (however, depending on perspective, this genus could be more than one, as will be encountered below).[56] And when they are compared with respect to their similarities, it is done on the basis of their differences. Therefore, it is impossible not to include both when distinguishing antithesis, metaphors, metonymies or synecdoches.[57]

2.2. Categorizing antitheses: As opposites and spatial domains

This section will present the different categorizations used in this study – partly on the basis of different kinds of opposites and partly on sensorimotor domains. How these different categories could be interrelated will be explored in the analysis. Regarding the spatial domains, these will only be touched upon and more thoroughly discussed on pages 16-17.

2.2.1. Five kinds of antitheses

Aristotle claims that things are opposed in four ways: "terms of relation" (FATHER/SON), "contraries" (GOOD/EVIL), "privatives" (SIGHT/BLINDNESS) and "contradictories" (TO BE/NOT TO BE). In the present study, the different antitheses are defined according to Aristotle with a modern interpretation by Fahnestock, developing contraries into not merely contraries but also reverse contrary contraries and intermediates.[58]

Contrast is usually divided into two groups, contradictory or contrary contrasts. A contradiction or a *contradictory* opposite exists between two words which are *incompatible*

[54] Harris (2013:8), Kjeldsen (2008:210-13)
[55] Burke (1945:24-25,143), Cruse (1986:197,206)
[56] Aristotle, *Categories* 14[a]19, Eriksson (2002: 338-39), Fahnestock (1999: 48-49)
[57] Lyons (1977:274,286), Richards (1976:120)
[58] Fahnestock (1999:48-49, 199)

with each other. They appear as "cuts", in comparison to contrary opposite which often is associated with "a scale". All must be defined in terms of one of the words and while denying one of them, the other is confirmed. It is A or NOT A – either you are alive or you are *not* alive.[59] MAN/WOMAN would be a contradictory opposite. This is quite similar to *dichotomy*, a communicative structure that is one of language's most fundamental characteristics. A dichotomy consists of two associated words which together cut the world in half and make it appear as 'it is either this' or 'either that' but never both.[60] Sometimes a dichotomy can create a so called dichotomy fallacy, where the binary categorization is a false construction of the world that sometimes is difficult to realize, and hence the receiver is fooled. [61]

A contrary contrast, however, consists of two words that are incompatible but where an object could be defined by neither of the words. Such word pairings are, for instance, BIG/SMALL, CHILD/PARENT, BUY/SELL, WIDE/NARROW and PULL/PUSH.[62] They can be further categorized. BIG/SMALL and WIDE/NARROW are *contraries*. Contraries are opposed terms which can be found under the same genus or oppositional genera (seemingly, this is important to all antitheses, and not only contraries), which in this case would be 'size' and 'closure'. They are neither true nor false but an entity could be categorized as both depending on perspective, time and relation.[63] Consider the antithesis BIG/SMALL: If you are SMALL, you cannot be BIG. But if you are not SMALL, it does not imply that you are BIG. In a certain context the antithesis can be put into a scaling system where the one of the words, constituting the antithetical pair, is either more A or B, a process that always includes comparison. By saying that something is BIG, you are simultaneously implicitly suggesting that something else is SMALL.[64]

CHILD/PARENT and BUY/SELL are *correlatives* and PULL/PUSH is a *reverse contrary*. Correlatives consist of antithetical elements that are related or connected somehow, such as by relation or by event. There is a cause and there is a consequence. Reverse contraries are contraries that depict a reversible event, such as PULLING and PUSHING open a door or OPENING and CLOSING a window; there is always a contrasting event, NOT A, that acts in the opposite way, towards A.[65]

Sometimes, an antithesis can be defined as neither of those mentioned above since there are many different options to one genus. To the genus 'color' there could be multiple

[59] Aristotle *Categories*, $13^{a}37$, see also Allwood & Andersson (1988:83-85), Fahnestock (1999: 48-49, 73)
[60] Sigrell (2014: 126)
[61] Hellspong (2011:301-2), Ibid. (2014:126)
[62] Allwood & Andersson (1988:83-85)
[63] Aristotle, *Categories*, $11^{b}33$ and $14^{a}15$, Eriksson (2002: 338), Fahnestock (1999: 48)
[64] Allwood, J. & Andersson, L.(1988:88-89), Bain (1908:196), Cruse (1986: 204,206), Fahnestock (1999:48-49, 73)
[65] Aristotle, *Categories*, $11^{b}24$ and $12^{a}26$, Fahnestock (1999: 49, 199)

antitheses and this applies as well for 'the four seasons' for instance. Depending on context different colors and seasons could be each other's opposites in from one perspective but not from another. When this is the case, the antithesis is an *intermediate*.[66] The five different categories are presented in Table A below.

Table A. This table presents the different antitheses which will be used in the analysis for categorization, where each is being described and exemplified by everyday antitheses as well as antitheses within molecular biology.

Antithesis	Description	Example
Contradictory opposition	These kinds of antitheses are contradictory and comprise antithetical elements which are each other's direct opposites, dichotomous, and can be placed in an either-or-relationship.	SAME/DIFFERENT, DEAD/ALIVE, 5'-END/3'-END, SPECIFIC/NON-SPECIFIC, INTRACELLULAR/ EXTRACELLULAR
Contrary opposition	These antitheses describe scalar dimensions. It comprises antithetical elements which are each other's opposites, but entails a gradable quality and can hence be viewed as a 'linear scale', with two poles and a zero-point	YOUNG/OLD, UP/DOWN, NEAR/FAR, INCREASE/DECREASE, UPSTREAM/DOWNSTREAM
Intermediates	This category concerns antithetical pairs which belong to the same genus where the antitheses within the genus could be each other's opposites. There are multiple ways of pairing the antitheses. Taxonomy could be involved here as well.	WINTER/SPRING/SUMMER/AUTUMN, EAST/NORTH/WEST/SOUTH, SOMATIC CELLS/BRAIN CELLS/STEM CELLS/BLOOD CELLS, MUTATIONS, MAMMALS
Correlative opposition	These are antitheses which comprise some kind of relation between two entities. Relationships belong to this category as well as cause-and-effect-relations.	CHILD/PARENT, BUY/SELL, VIRUS/HUMAN, ACCEPTOR/DONOR, GROW/DIVIDE
Reverse contrary opposition	The antitheses belonging to this category are each other's reverse contrary opposites. Together, they comprise a reversible event. Not all events are reversible.	PUSH/PULL, OPEN/CLOSE, ENDOCYTOSIS/EXOCYTOSIS, BREAK/HEAL, LEADING STRAND/LAGGING STRAND

Antithetical elements are "the 'most readily apprehended' of sense relations"[67] because they constitute one of the essential pillars of language, encountered everyday, which becomes embedded in mind once learning the native language starts. The essence of antithesis, contrasts and the contradictory division, is thus intersubjective and incorporated in language, and perhaps also in thought and in how we are orienting ourselves in our surroundings. Antitheses seem to create a perspective that makes us categorizing our world in what are thought to be the most common antithetical concepts, namely contradictory oppositions (according to Lyons and Jones for instance) or contraries (according to Aristotle).[68] There is no sufficient answer to why that is but it may have to do with that two-member systems, such as antithesis, form close association which may help the understanding due to definition and clarity. Man seems prone to organize the world in dichotomous oppositions; hence it is a

[66] Aristotle, *Categories* $12^{b}26$, Eriksson (2002: 340)
[67] Jones (2002:2)
[68] Eriksson (2002: 338), Fahnestock (1999: 48), Lyons (1977:278)

natural process to human beings in order for us to comprehend the extralinguistic world. [69]

The elicited antitheses from the lectures will not only be categorized as opposites but also with regard to spatiality and sensorimotor domains. How these are related to antithesis will be proposed below and explored further in the analysis. The sensorimotor domains, used in this thesis are *motion, orientation* and *space,* which are part of Lakoff and Johnson's "embodied mind theory". As will be further discussed below, there are conventional concepts within molecular biology (i.e. *ordo naturalis*) which partly seem to rest on antithetical, spatial relations and can be correlated to bodily experience. Since bodily experience is hypothesized to be important to understanding, these concepts and categories seemed relevant to the analysis (e.g. the second and third research questions).[70]

2.2.2. Pitfalls: Context and countless antitheses

Since antithesis can only be identified by consensus and context, it is difficult and problematic to study – word pairs can be antitheses in one context, but not in another, but they must be argued.[71] This is how the empirical data and the elicited antitheses will be dealt with; For instance, 80 years ago, MAN/WOMAN would be an evident antithesis, whereas today, with three or more genders added to the category of gender, the antithesis MAN and WOMAN may only apply in certain contexts. Furthermore, there are probably words that do not have any evident corresponding opposite, but still do have such in at least one context. What is the opposite of TABLE for instance? In one context, it might be CHAIR, and in another, it might be ELBOW. This issue will be addressed later in the third section. Moreover, words are sometimes felt to be opposites but their oppositeness is difficult to justify since they do not come across as 'perfect antitheses' – the antithesis RECEPTOR/LIGAND could easily be recognized to a molecular biologist, such as a Nobel Prize laureate and his or her students. To a non-molecular biologist, however, such an assumption would be ridiculous without an explanation; hence the receiver needs prior knowledge to grasp the antithesis. Such opposites are so called "local".[72] Additionally, sometimes a pair of words is not lexically but implicitly antithetical. This applies for the biological antithesis 5'-END and 3'-END. The pair END/END is not antithetical, nor is 5'/3'. However, these expression concerns the different ends as well as directions of DNA, which is evident in a biological context. Therefore, this pair is antithetical. The figure has been used in scientific argument to make pairs of words forceful, just like the

[69] cf. page 10f. See also Gärdenfors (2014:25), Jones (2002:2,168-69), Lakoff & Johnson (1999:19), Lyons (1977:270)
[70] cf. pages 3,6ff
[71] Eriksson (2002: 338, 352), Fahnestock (1999:49), Gärdenfors (2014:241), Jones (2002:175)
[72] Cruse (1986:257-58), Eriksson (2002: 340, 352), Fahnestock (1999: 47)

antitheses just mentioned, since they do not come across as such otherwise. [73]

Connotations to words might also weaken the antithesis and make it appear less explicit (recall the importance of explicit parallelism, intra- or intersententially, in 2.1.1. Antithesis: As rhetorical device and pragmatic tool) – such as categorizing something as "work" or "play". Exercising for instance, might be interpreted as both. Some words may also have many opposites, and do therefore belong to intermediates. WINTER and SUMMER could be an antithesis, but so could WINTER and SPRING. Obviously it depends on the context. Meanwhile, all communication is supposed to be interpreted with regard to context, and therefore this 'context dilemma' is not exclusive to antithesis.[74]

2.3. Understanding and meaning-making: Spatial relations and active processing

Regardless of context, understanding seems to deal with contrast, and more specifically on shifts in perception of the world where previous, stored knowledge is used in order to make sense of new information – a process wherein the previous knowledge is altered together with the new. If so, memory is probably also being used (as will be further elaborated on below) as is comparison (which was mentioned on page 10-11).[75]

2.3.1. In order to understand we have to remember

One of the cornerstones of understanding might be *memory*.[76] Understanding is a psychophysiological process (comprising both the intellect and the body) which includes *memorization* and *making intellectual and practical sense of experienc*e. By means of memorization, a process that must take place in order to make sense of what is experienced, new experiences are compared with old ones by which new connections can be made and new associations can be formed. Memory is hence important to understanding, and since memory partly involves comparison, comparison might also be a fundamental process.[77]

Clearly, memorization is a very broad notion. Caine et al. (a professor in education and a PhD in educational psychology at California State University and Florida University respectively) focus on two cognitive mechanisms, namely "archiving isolated facts and skills" and "making sense of experience".[78] *Active processing* is a cognitive method and process which comprises both these mechanisms, and is a way of memorizing what is being learnt. It

[73] Fahnestock (1999:69-70)
[74] Cruse (1986:262)
[75] Bain (1908:196,234,260), Caine et al. (2005:120), Richards (1976:29), Ödman (2007:31)
[76] Memory is of course strongly related to *memoria*, the fourth canon within rhetoric.
[77] Bain (1908:234), Beaugrande (1979:260), Caine et al. (2005:5,68,73), Lakoff & Johnson (2003 [1980]:57), Richards (1976:29-30,125)
[78] Caine et al. (2005:2-3,187)

is "the art of digesting, thinking about, reflecting on, and making sense of experience"[79] – processes which might be intertwined in the comparative step of realizing antithesis. All experience is being processed in order to be understood, but if actively reflecting upon it, i.e. applying active processing as a method, understanding might perhaps become easier, by means of meta-cognition ("thinking about the way one thinks"[80]).

Understanding is undoubtedly a complex mental operation which itself entails, apart from memorization, other complex processes, such as meaning-making and conceptual thinking. In this study, understanding something conceptually means that it is understood by means of something else. Moreover, understanding is a mental process in which information is organized in terms of both physical objects and relationships (in what ways objects connect).[81] Meaning-making can be described as the process of organizing information "in abstract spatial structures that are expressed in terms of *dimensions, distances, regions* and other geometric notions", such as sensorimotor domains which will be explained in the next section.[82] Spatial-relations concepts can be found at the core of the conceptual systems and these are essential in the process of making sense of what we believe is reality, which will be discussed further below.[83]

2.3.2. An antithetical, embodied mind?

As mentioned in the introduction, another hypothesis within cognitive semantics, related to the metaphor theory, is that the mind and its concepts are inherently embodied.[84] "*An embodied concept"*, Lakoff and Johnson explain, is a *"structure that is actually part of, or makes use of, the sensorimotor system of our brains. Much of conceptual interference is, therefore, sensorimotor inference*", within which spatial-relations concepts are included.[85] The understanding of what the mind might be and how it might work matters because it also affects the interpretation of reason, and if the mind is embodied, then reason too is formed by our bodily experience.[86] Furthermore, since reasoning is a process of meaning-making and understanding, these processes might also be founded on our bodily experiences.[87]

Included in the cognitive operation of embodying and understanding different perceptions of the world, is the process of categorizing concepts – by spatiality for instance.

[79] Ibid. (2005:179-80)
[80] Ibid. (2005:182)
[81] Gärdenfors (2014:25), Ibid. (2005:73,153)
[82] Gärdenfors (2014:21)
[83] Lakoff & Johnson (1999:30)
[84] Ibid. (1999:3), Gärdenfors (2014)
[85] Ibid. (1999:20)
[86] Ibid. (1999:4)
[87] Gärdenfors (2014:4), Lakoff & Johnson (1999:6,17)

The spatial-relations concepts belong to the "Primary Metaphors", metaphors founded on the bodily experience of the world, and which relate distinct concepts. [88] Lakoff and Johnson partly divide each primary metaphor into so called sensorimotor domains: a) "*Categories Are Containers*", sensorimotor domain: Space, b) "*More Is Up*", sensorimotor domain: Vertical orientation, c) "*Change Is Motion*", sensorimotor domain: Moving. A sensorimotor domain is thus an experientially domain by which we categorize how we experience something – like an object containing something, as a vertical direction, or as a movement.[89] The point, however, is that the common denominator among these concepts and their sensorimotor domains is that they belong to and become visualized as spatial metaphors or – from the very essential perspective of this study – spatial antitheses. How?

2.3.3. Conceptual antithesis in language and thought?

We might use spatial-relations concepts unconsciously and automatically perceive and categorize things as *in*, *on*, or *across from*, *up* and *down* in relation to something else [90] – even in scientific language, as will be discussed to a great extent in the analysis below.

How are we to understand the essence of such spatial orientations as UP and HIGH without contrasting them to DOWN and LOW? What do they mean without having each other as contrasts?[91] If we, by consensus and by scientific method, could confirm the Lakoff and Johnson's hypothesis, antithesis seems indeed to be an essential part of the conceptual mind. If putting on glasses which allows for realizing antitheses, these could be found when studying the metaphorical concepts in the conceptual metaphor theory. When approaching the conceptual metaphors as antitheses instead, antithesis seems not only essential to the structure of mind but just as fundamental as metaphors are claimed to be.[92] Furthermore, Lakoff and Johnson conclude the following when discussing whether anything can be understood without conceptual metaphors: "The prime candidates for concepts that are understood directly are the simple spatial concepts, such as UP. Our spatial concept UP arises out of our spatial experience".[93] Other spatial concepts are FRONT-BACK, IN-OUT and NEAR-FAR. Ultimately, it seems that these spatial, antithetical metaphorical concepts could be important to mind and reason, and could be embodying the mind. What should be emphasized here is that these concepts can be regarded as antitheses, thus antithesis can be a fundamental element to

[88] Evans (2007:166)
[89] Lakoff & Johnson (1999:47-54)
[90] Ibid. (1999:20,31)
[91] Jones (2002:3)
[92] Ibid. (2002:6), Kjeldsen (2008:236)
[93] Lakoff & Johnson (2003 [1980]:56)

understanding. [94]

Additionally, not only may directional oppositions make understanding more efficient but oppositions in general, which are somehow related to or compared to our bodies and the external world, such as moving or visualizing something in space. Although it is a digression, it must be pointed out that Lakoff and Johnson appear not to have been the first to discover a probable correlation between understanding and bodily experience. Lyons, who Lakoff and Johnson do not refer to, stated that: "Furthermore, it may well be that our understanding, not only of directional opposition, but of opposition in general, is based upon some kind of analogical extension of distinctions which we first learn to apply with respect to our own orientation and the location or locomotion of other objects in the external world". [95]

In order to clarify my point, let us have a closer look on the three already mentioned primary metaphorical concepts: a) *Categories Are Containers* – sensorimotor domain: Space – if something cannot be defined as *in, on, outside of,* then what does it mean to say that something is *out, under* or *inside of* something else?, b) *More Is Up* – sensorimotor domain: Vertical orientation – if there is no opposite to *up*, thus there is no *down*, what does it then mean to say that more is *up*?, c) *Change Is Motion* – sensorimotor domain: Moving – if there is no such concept as *rest*, it would not be possible to reason about change as motion because *motion* would not mean anything. [96] AT first glance in the empirical data, such concepts can be found, as will be presented, discussed and evaluated in the analysis below. However, the main point is that without the antithetical elements, comprising the conceptual metaphors (their opposition of *res*), they are simply nothing – at least from this perspective. Lakoff and Johnson's hypothesis can thus be approached from at least, two perspectives.

Note that it is neither important nor relevant to employ or mention whether antitheses in the analysis belong to any of the primary metaphors since the thesis does not concern conceptual metaphors. The importance and relevancy of primary metaphors, however, is the underlying sensorimotor domain, that perhaps could be correlated to antithetical spatial-relations. Since there are numerous sensorimotor domains (such as *temperature, physical support, muscular exertion* etc.) only three will be used here, which are *orientation*, *motion* and *space*. Why these three were chosen is motivated on page 25.

[94] Cruse (1986:223), Ibid. (2003 [1980]:56-57)
[95] Lyons (1977:282)
[96] Lakoff & Johnson (1999:50-54)

2.4. Employed terms – and bringing the theories together

According to the theoretical framework, antithesis and understanding may be interrelated, but how? Is it important to understanding? Understanding is a psychophysiological process, which entails meaning-making and conceptual thinking. From one perspective, these processes include categorization of sensorimotor inference and hence spatial-relations concept, within which antithesis may play an essential part.[97] Furthermore both understanding and antithesis entail the process of comparison, which memorization is a part of. Comparison is a crucial process in the realization of an antithetical expression, implicit or explicit. Explicit antithesis is similar to definition, since both comprise the following: Whilst something is defined, there is a parallel, ongoing process which defines what something is not. It hence seems to have a clarifying function to information.[98]

The antitheses will be categorized according to Table A, as well as whether they are *active* (or not active) and *spatial conceptual*. These terms were invented for the study, based on the theoretical framework, and are defined as follows:

(1) An *active antithesis* is an opposite that is explicitly put alongside its corresponding opposite. If both words of the antithesis are explicit and in close relation in the context, i.e. intrasentential (an antithetical pair can be placed far away from each other in the text as well, i.e. intersentential).[99]

(2) According to the theoretical framework, those antitheses that are more spatial seem to make the process of understanding more efficient. This will be analyzed. Since spatial antithesis seems embodied, as does reason and mind (which are used when trying to understand the world and everything that belongs to it), it is perhaps easier to grasp and understand the information that the spatial-relations conceptual antitheses provide. Thus, if the antithesis is *spatial conceptual*, it is put in words that are based on sensorimotor domains which can be related to *orientation*, *motion* and *space*.[100]

[97] cf. pages 8-10
[98] cf. page 10
[99] cf. pages 8-10
[100] cf. pages 16-18

3. Methodology and empirical data

A rhetorician searches for different possible meanings of communicative events and for a deeper understanding of what is analyzed. A rhetorical analysis concerns "the description, analysis, interpretation, and evaluation of persuasive uses of language".[101] Thus, the aim of the analysis is to describe, understand and evaluate the artifact within its context, by means of rhetorical theories and methods.[102] On the basis of hermeneutics, comparative stylistic and antithesis content analysis methods were employed in this study.

3.1. Empirical background: Nobel Prize lectures in Physiology and Medicine

The empirical data consists of the ten latest Nobel Prize (written) lectures in Physiology and Medicine, selected from the years 2008-2013 (collected on February, 10 2015). They are discussed in the analysis, but only to some extent, and always in comparison with the one lecture which forms the basis of the analysis: *The Molecular Machinery of Neurotransmitter Release* by Thomas C. Südhof. It was chosen to represent all lectures since it includes the most antitheses, encountered in the other lectures as well, and thus seems to be the most suitable lecture to present. Since the study concerns how present language use can be changed, it seemed reasonable to collect the most recent lectures. It should be noted that some lectures were removed due to one of the following reasons: Either because the lecture was not held by the laureates themselves, or because the lecture (in writing) was not available at Nobelprize.org when they were collected for analysis. This was the case for Schekman (2013), Gurdon (2012), Steinman (2011) and Edwards (2010).

All lectures share the same layout which makes the empirical data inter-comparable. They all start off with a background, describing their life journey and how that journey resulted in a Nobel Prize. Then the findings (for which they are being celebrated) are presented and discussed – always in relation to the laureate's personal background. The target group of the lectures is not defined. It would however be reasonable to assume that the primary target group is interested in the Nobel laureate's research field and on what premises the laureate has won the prize. Meanwhile, these are public and can be viewed on television or on the web, hence the target group could include all who are interested in the research of the laureates.[103]

The empirical data, comprising natural scientific information (as it is often formulated and expressed in text books regarding molecular biology, as mentioned in the introduction), is

[101] Campbell & Burkholder (1972:12)
[102] Andrews (1990:55), Viklund (2014:13-14)
[103] For instance on SVT, Nobelprize.org or UR.se

suitable for this study because it seeks to analyze in which way antitheses appear in the scientific language that students may encounter during their education. The Nobel laureates are probably not using the antitheses consciously, and therefore it is possible to explore where antitheses can be found in the text and what they may be doing with it. The empirical data hence allows for the study of whether antithesis is used, and if so, how it is used, what it does to the texts and if or how it can be correlated to how well and efficiently information is understood by means of clarity. Nevertheless, some other empirical data could possibly have been chosen, but since the lectures were easily accessible and met the qualifications for the requested artifacts, these were used.

3.1.1. Drawbacks on empirical data

One of the more crucial drawbacks of this study, with regard to the aims of the study and the research questions, is that the empirical data only concerns written language and not speech. Even though written and spoken language is connected in many ways they still differ in others. If the results show that there are antitheses in the texts which seem significant to understanding, this does not necessarily have to apply for spoken language in the same way. If there are no antitheses or if there are no implications on that they are important to understanding, this might still apply in spoken language.

Nevertheless, it is also an advantage to study written language, especially in this thesis, since it concerns cognitive rhetorical features, which are expected to be as influential on understanding in written form as in speech. Since the aim of this thesis is to explore whether antithesis may enhance natural science students' understanding of complex information, in order for them to improve their skill on popular science communication, it does not matter whether the empirical data is spoken or written since popular science communication concerns both speech and text. Additionally, by studying written language, I will not be disturbed by other rhetorical figures or attitudes, such as irony.

Another, more difficult drawback to defend is the fact that my native language is Swedish and not English, which is the employed language in the empirical data. Due to expressions, synonyms and such that may differ between the languages, this could yield less appropriate interpretations of antitheses. However, the biological language, used in the artifacts, is a universal language and because this is the focus of the analysis, it will hopefully reduce the impact of the human factor regarding the different languages.

Since this is a case study I will only be able to draw conclusions, based on the results from this study and collected empirical data. Meanwhile, by means of how this study is

conducted – with specified methods and theoretical perspectives and approaches – the conclusions could possibly yield tendencies which are to be viewed in other, similar, case studies.[104]

3.2. Study design

The methods used will be described and discussed in this section and on what theories they rest. Except hermeneutics, the section includes how the antitheses were found and categorized and what difficulties the identification and categorization of this rhetorical device brings.

3.2.1. Hermeneutics and rhetoric – a sisterhood

Rhetoric is tightly interwoven with hermeneutics. The purpose of a hermeneutic analysis is basically the same as a rhetorical one: To study, interpret, and evaluate the content and the structure of a communication situation, from different perspectives, as well as understand what is being said, explicitly and implicitly.[105] Since "all texts and all speech are basically related to the art of understanding, hermeneutics", rhetoric and hermeneutics rely on each other and are each other's inverses.[106] This makes hermeneutics a suitable methodological perspective for the present study. Moreover, it allows for the subjective study and categorization of the empirical artifacts, as well as an analysis on an antithetical element which can be both explicit and implicit, and take different forms, depending on how it is being approached. Additionally, hermeneutics seeks to better understand what was previously not so well understood, which is also one of the aims of the present study, concerning the role of antithesis in a natural scientific context.[107]

Rhetorical analyses almost exclusively deal with qualitative methods, which are employed in this study as well. Such methods are deeply connected to hermeneutics since they are based on interpretation, as is the analytical work, which is what hermeneutics is concerned with.[108] Hermeneutics deals not only with the interpretation of what appears to be reality but it also describes how we understand and 'know' what reality appears to be. By analyzing and interpreting the parts, the understanding of the whole (within which the parts are operating) becomes easier to grasp.[109] This is what a rhetorician would call 'the rhetorical situation'. Within hermeneutics, it is called "the hermeneutic circle".[110]

All research is subjective to some degree, and so is interpretation. Therefore it is

[104] Andrews (1990:57)
[105] Mailloux (1996:316), Ödman (2007:13,53,74)
[106] Gadamer, Weinsheimer & Marshall (2004:188)
[107] Viklund (2014:21), Ödman (2007:75)
[108] Mailloux (1996:316,318), Hellspong (2001:99,160), Viklund (2014:21,23), Ödman (2007:13)
[109] Andrews (1990:46), Ödman (2007:99)
[110] Gadamer, Weinsheimer & Marshall (2004:306-7), Ödman (2007:100,102)

important to discuss and problematize how the researcher is involved in the analytical process. Due to that it is impossible to avoid the subjective interpretation of the empirical data, there is a risk of focusing on some perspectives while ignoring others. However, there are ways of conducting a scientific study regardless of the subjectively interpretative researcher, such as being aware of subjectivism as well as always comparing the results with and analyzing the empirical data on the basis of the theoretical perspectives and approaches.[111] The main point is to conduct the research in such a way that it is intersubjectively understood and (hopefully) accepted.

This qualitative study has an inductive approach. I will start off by studying and analyzing the collected empirical data, consisting of the written lectures, on which conclusions will be drawn. Below, the empirical background and data are presented, as are the methods used for conducting the analysis.

3.2.2. CTA and comparative stylistic analysis

The written lectures were initially approached with a close textual analysis (CTA), as a pre-study to the rhetorical stylistic analysis. CTA implies an empirical approach, upon which a deeper understanding is gained about why the studied artifact is constructed in this particular manner and how the appearance and content of the artifact are related.[112]

The rhetorical stylistic analysis focused on the antithetical elements but discussed the text as well as *res* and *verba* (as does antithesis).[113] This was accomplished by both digesting the texts into parts and then bringing the parts together again (synthesis). Stylistic analysis was chosen as a method for the study since it allows for studying what stylistic elements are doing to the text and what communicative effects arise from their usage. The analysis thus concerns the pragmatic aspects of language. In this study, an antithetical approached was applied which made it possible to discover and study such elements, hence the 'antithesis-labeling'. It is not interesting to know that a word or concept can be interpreted as an antithesis, but what the antithesis does to that word or concept and to the context. That is what shall be explored.[114]

The comparative part of the analysis will include both comparisons between antitheses in Südhof's lecture, as well as between his and the other nine. The purpose of the comparative part of the analysis was to point out similarities and differences between the lectures as well as shedding light on what might be unique (or not) to some one of them. More important, the

[111] Ödman (2007:63-64, 71)
[112] Andrews (1990:46), Browne (2009:63-67)
[113] Sigrell (2014:120)
[114] Hellspong (2001:69,73), Ibid. (2014:119-20)

comparative part allows for the study of how *res* and *verba* are influencing each other, i.e. how antitheses are influencing the way the information is being conveyed.[115]

The antitheses will be distinguished and defined according to different oppositions, described in Table A, and three sensorimotor domains: *Motion, orientation,* and/or *space*. These are found partly based on the genera, within both the opposite comprising the antithesis, share similarities and differences. Secondly, the defined antitheses will be categorized as being active or not (or in some cases both). As a last step, the elicited antitheses will be evaluated on if and how they might enhance or aid understanding.

Antitheses will be found on the basis of the definition of antithesis, given and discussed in 2.1.1. Antithesis: As rhetorical device and pragmatic tool. Both conventional (UP/DOWN) and context-based (ENDOCYTOSIS/EXOCYTOSIS) will be found with regard to what is being discussed in relation to the antithesis since this study wishes to study what the antithesis does to the information which is to be understood. Both explicit and implicit antitheses are expected to be found. The categorization will be conducted according to 2.2. Categorizing antitheses: As opposites and spatial domains where the antitheses found will be compared with those defined. Once the antitheses have been categorized, they will also be discussed whether they are spatial, and if yes – then in what/which way(s).

3.2.3. Difficulties on finding and categorizing antithesis

Antithesis can be studied from both conceptual and lexical approaches (and many others). Both will be applied here, but the conceptual approach is emphasized – partly because it will yield more qualitative results, and partly because a lexical approach is insufficient when explaining why some words are recognized and interpreted as opposites and some are not. From a rhetorical perspective it is difficult to predict what an antithesis is and what it is not since it is contextually-based, as mentioned in 2.2.2. Pitfalls: Context and countless antitheses.[116] From one point of view, "any opposition can be licensed within an appropriate context"[117]. This is however not interesting in the present analysis. The point is *not* to elicit all possible antitheses, but to elicit the antitheses that are *constructive* (to understanding) in correlation to the subject matter. The study explores whether antithesis could contribute to a more efficient understanding, hence, the antitheses should – in some way – be related to the scientific information.

Furthermore, it is difficult to find all antitheses, hence there are probably antitheses left

[115] Hellspong (2001:78-79)
[116] Fahnestock (1999:48), Jones (2002:23,175), Murphy (2003:169, 183, 188)
[117] Jones et al. (2012:4)

in the text which I have not presented or analyzed. Meanwhile, the most important perspective to my study is that antitheses are analyzed in their context and that their potential positive effect on understanding in the lectures, with regard to presenting abstract information, is discussed. I have, however, chosen not to analyze the figure texts in the lectures, or text which does not concern scientific facts, such as personal anecdotes, due to the time and space limit of this thesis.

Categorizing the antitheses according to the employed terms is also challenging since an antithesis probably can, as mentioned before, be interpreted as both, say contrary and contradictory, depending on how the element is approached. This is however not a surprising methodological problem, but is expected, as rhetorical figures allows for the study of many perspectives. Concerning the sensorimotor domains, I will only categorize the antitheses found as belonging to *motion, orientation* or *space* (or none of them) since these are most easily related to bodily experience and spatial relations in space.[118] It should be mentioned that Lakoff and Johnson categorize *size* as a sensorimotor domain ("*Important is Big*"), which I do not. I will categorize size-related antitheses as *orientation* due to its gradability. Gradability is generally interpreted as a linear scale, an abstract directional line in space, which belongs to *orientation*. Hence *size* is included in *orientation*.[119]

Finding explicit antitheses is based on sorting out the genera within which the different opposites differ, and is not as problematic as finding implicit antitheses. The implicit antitheses which comprised quite conventional opposites are likely to be found. This is perhaps also the only way they can be found since the definition of an implicit requires conventional opposites. However, they could of course be conventional 'local' opposites.[120]

[118] Lakoff & Johnson (1999:51-54), Fahnestock (1999: 73)
[119] Allwood & Andersson (1988:89), Cruse (1986:204-5), Ibid. (1999:51-54)
[120] cf. page 14

4. Analysis and results

All antitheses, found in the ten lectures, are presented in the included attachments, and all are analyzed according to the suggested model above: What kind of antithesis there are, if they are active, whether they are spatial or not, and if they somehow contribute to a more efficient understanding. The following quotes, presented in the tables, are excerpts from Südhof's Nobel Prize lecture, *The Molecular Machinery of Neurotransmitter Release*. The excerpts, apart from the first three, are presented in chronological order. Sometimes, a quote comprises more than one antithetical pair, which is marked by small letter [a], [b] and so forth, which also are referred to as numbers.

4.1. Antitheses in Südhof: The Molecular Machinery of Neurotransmitter Release

When the brain wants to share information, command different parts of the body to do something, it uses neurons (brain cells) as its communicators. These neurons produce messenger molecules (neurotransmitters), which are sent to different places in the body, in order to convey the brain's information. During the transport, which could be a quite long distance (even though most cells are very close to one another), many of these messenger molecules are packed in vesicles, small 'transport bubbles', held together by cell membrane.

This lecture, given by Thomas C. Südhof, 7th December 2013, discusses how neurosignals (signals between neurons, containing messenger molecules) are passed on from one neuron to another by means of vesicles. By studying mice, Südhof managed to "demonstrate how vesicles are held in place, ready to release signal-bearing molecules at the right moment".[121]

4.1.1. Excerpts 1 to 5: All domains, pre-knowledge and implicit antitheses

Excerpt 1

	Antithesis	Sub-group	Active	Spatial
1	"Synapses DIFFER DRAMATICALLY from each other in properties such as strength and plasticity, but always operate by THE SAME canonical principle to achieve this speed" (p. 260)	contradictory/ contrary opp.	Yes	No/Yes (orient.)

This excerpt describes some characteristics of synapses. The active but non-spatial antithetical pair DIFFER/SAME is opposite in meaning and hence forms a contradictory opposition. However, if the antithesis is interpreted as a contrary opposition (which is a possibility since

[121] Nobel Media AB, Thomas C. Südhof – Facts (2014)

'how different' and 'how similar' two entities are can be interpreted as a gradable concept, which implies a contrary opposition), the antithesis belongs to *orientation*. Why it belongs to *orientation* – a categorization made merely on the premise that the antithesis comprises a contrary opposition – is due to the spatial characteristic of a contrary opposition. If something is gradable, it is most likely to be interpreted as an abstract linear scale, and because such a scale probably involves the spatiality of a horizontal direction, it involves *orientation* as a sensorimotor domain.[122] Even though there probably are exceptions, contrary oppositions might enhance understanding more than other opposites do due the bodily experience that comes along with it, i.e. the gradability, which entails a linear scale, which the receiver probably uses when interpreting a gradable antithesis.

As already mentioned, the antithesis comprises a contradictory opposition which seems to function in the same way as an active antithesis, namely bringing forth the opposition. The dichotomous relationship makes the antithetical pair stronger in relation to each other, and might thereby become recognized as more evident.[123] Consequently the mind realizes the difference in a more efficient manner, i.e. active processing can occur more easily as could perhaps memorization.[124] For more examples, comprising a contradictory and a contrary opposition, please view Rothman (28), Greider (12) or Blackburn (14, 37).

Excerpt 2

	Antithesis	**Sub-group**	**Active**	**Spatial**
2 **3** **4** **5**	"When an action potential travels DOWN [a] an axon, it DEPOLARIZES [b] the nerve TERMINUS [c] and OPENS [d] presynaptic Ca^{2+}-channels" (p. 260)	a. contrary opp. b,d. contrad-ictory opp. c. reverse contrary opp.	No	a. Yes (motion, orient.) b,d. Yes (motion) c. Yes (orient.)

This excerpt describes how an action potential influences a neuron in order to pass the action potential forward. The antitheses in the excerpt are implicit and hence not active but they are however spatially conceptual. In antithesis [a], something travels DOWN something else, which implies that it could travel UP as well (compare with Excerpt 9, antithesis [a]). Because of the vertical direction, as well as its gradability (contrary opposite), the antithesis belongs to *orientation*. Antithesis [b] implies that the axon (a long rod-like part of the neuron which links the head of the schematized neuron and its synapse, the end) is either DEPOLARIZED or POLARIZED (which makes the opposition contradictory) and by stating that it is depolarized

[122] cf. page 13, Table A
[123] cf. page 10, 12
[124] cf. page 15

implies that the action potential gives rise to a change of state in the neuron, from 'polarized' to 'depolarized', hence *motion*. The third antithesis, [c] TERMINUS, reveals that a neuron has a 'start' and an 'end' (a reverse contrary opposition); hence [c] describes the morphology of the neuron. Finally, [d] consists of the antithetical element OPEN, and by stating that the channels are 'opened' implies that they are otherwise 'closed' (hence contradictory). The antithetical (implicit but conventional) oppositions seem to heighten the contrast.

All of these implicit antitheses are, as mentioned, not active but spatial. An explicit antithesis is thought to clarify *res* more than does an implicit one since the implicit invites ambiguities. Nevertheless, if each antithetical element would be accompanied by its corresponding opposition, the information provided in the excerpt explanation would perhaps be superfluous, which in turn could confuse the receiver (or sender for that matter). Moreover, since the 'lonely' antitheses entail words with quite conventional opposites, it is likely that the receiver will interpret the implicit antitheses as explicit ones. Therefore, active antitheses might not always be needed for the most efficient understanding.

The antithetical elements are spatial in different ways which enriches and strengthens the bodily experience due *orientation* and *motion*, which seem to be part of the antithetical expressions. Not only can the mechanism be related to that something is 'moving down', but also what the destination is, i.e. 'the end', TERMINUS. Moreover, when the action potential has reached the end, the channels are opened upon which the Ca^{2+} (calcium ions) flow into the synapse, which subsequently becomes depolarized. This mechanism can be interpreted in correlation to the receiver's already experienced, directional body movements (such as travelling UP something, or going DOWN, OPENING a door or CLOSING a window, having our feet as a TERMINATING body part and our head as the START). By means of the comparison taking place between previous bodily experiences and the evoked visualization, interpreting and understanding the abstract information might become enhanced since it probably becomes easier to relate to.

Excerpt 3

	Antithesis	**Sub-group**	**Active**	**Spatial**
6	"The IN-FLOWING Ca^{2+} then triggers neurotransmitter RELEASE" (p. 260)	correlative/ contrary/ contradictory opp.	Yes	Yes (motion, orient., space)

This dichotomous 'in-out-event' – concerning calcium ions and neurotransmitters – makes the antithesis a contradictory and a contrary opposition, but it is also a correlative opposition due

that it describes a cause-and-effect relationship between calcium ions and the reaction of the neuron (when the ions flow into the neuron, the neurotransmitters are released.

The antithesis is active and belongs to all sensorimotor domains. It belongs to *motion* since it depicts a movement into something (IN-FLOWING). As the movement implies 'into', the antithesis entails *orientation* but also *space* since the synapse can be interpreted as a container, in which the neurotransmitters are moving. Perhaps it could be the contrary opposition that enhance the appearance of *motion* and *orientation* due its relation to a gradable scale. By contrast, a contradictory opposition seem to make the oppositional pair, and hence the antithesis, cut in pieces, which then might not be as easily interpreted as a movement which the excerpt presents.

In comparison with Excerpt 9, this excerpt might make the understanding even more efficient due that the antithesis, alone, provides three ways of relating it to bodily experience. See and compare with Figure 1: The stick man 'puts' (a movement, hence *motion*) his head 'in' (a horizontal direction, hence *orientation)* 'the letter box' (a container, hence *space)*. Thus, not only are the contradictory and contrary opposites bringing forth the content of the quote, but so do the antithetical elements of the sensorimotor domains. Antitheses that comprise all three categories are also found in Rothman (28), Greider (25) and Blackburn (45, 48).

Excerpt 4

	Antithesis	**Sub-group**	**Active**	**Spatial**
7 8	"After EXOCYTOSIS [a], synaptic vesicles recycle by different pathways, including FAST [b] ENDOCYTIC [a] mechanisms that are sometimes referred to as 'kiss-and-run', as well as SLOWER [b] endocytic mechanisms involving" (p. 260)	a. reverse contrary/ contradictory opp. b. contrary/ contradictory opp.	Yes	Yes (motion, orient.)

This excerpt describes what happens after the neurotransmitter release in an antithetical way where. Exocytosis means that the 'bubble' (vesicle) is disbudded from the neuron, and endocytosis is the reversible mechanism, i.e. the vesicle merges together with the corresponding synapse of another neuron, hence a reverse contrary opposition. Meanwhile, EXOCYTOSIS/ENDOCYTIC are each other's direct opposites, and therefore the antithesis is a contradictory opposition as well. This reversible mechanism of 'disbudding' (EXOCYTOSIS) and 'merging' (ENDOCYTIC) are movements (hence *motion*) between synapses or inside/outside a synapse (hence *orientation*). As in Excerpt 2, the antithetical structure seem

to make the spatiality more prominent, because without the quite evident and contradictory oppositions, the antithesis might have been constructed of "local" opposites, which do not seem as evident to all.

The antithesis is active, as is the following antithesis, [b] – an antithetical pair, comprising FAST/SLOWER. It thus entails the gradable concept of 'speed', and is therefore a contrary opposition. However, [b] is also a contradictory opposition due to that SLOWER and FAST could be interpreted as direct opposites – at least in this context. As in [a], [b] too belongs to *orientation* (the gradability of 'speed' can be interpreted as an abstract linear scale in space (directional, horizontal line)) and *motion* (since [b] describes the movement of [a], as well as the expression "'kiss-and-run'"). Both produce symmetry which could increase the receiver's attention towards the presented information due that the sense of perhaps increases. Consequently, the receiver could remember this information more easily.[125]

These antitheses could contribute to a more efficient understanding in the same way as previous (and some below, c.f. Excerpt 9) active, spatial conceptual antitheses do. Still, antithesis [a] problematizes this assumption due that the opposites are "local". If not familiar with EXOCYTOSIS/ENDOCYTIC, nor know with which mechanisms they refer, the antithesis they comprise might not be realized. This is not the only local pair. Other antitheses that seem likely to enhance understanding, but are quite pointless if the receiver does not understand what they mean, are: 1) antithesis 26 in Barré-Sinoussi, which entails HOST/VIRUS. If the receiver does not know that the animal carrying the virus is called "host" (hence, correlative opposition), the antithesis is not easily realized; 2) antithesis 26 in Hoffmann that comprises the pair LIGAND/RECEPTOR. A ligand is a molecule that binds to a receptor (the relationship between these can be compared with PARENT/CHILD) which affects one or many mechanisms in some way (activation of a reaction for instance) – a ligand is like a key to a car that is needed for starting the engine. But if the receiver does not know this, it would be very difficult to convince her that it is an antithesis; 3) antithesis 3 in Yamanaka, comprising the antithetical elements ES CELLS/SOMATIC CELLS. If the receiver does not know that ES cells are embryonic stem cells, i.e. cells which have the potential of becoming any cell type and that "somatic cells" are an umbrella term for all the body's cells, this pair would probably just be empty words; and 4) antithesis 11 in Rothman, which entails the antithetical pair PARENT/SHIFTED band – an antithesis that concerns a specific methodology (so called 'gel electrophoresis' which will be discussed in 4.3. Only, or not at all in Südhof) where the bands

[125] cf. page 10

are samples that have travelled on a gel and separated themselves from each other so that the researcher can determine what the samples are.

Excerpt 5

	Antithesis	**Sub-group**	**Active**	**Spatial**
9 **10**	"Compared to PRESYNAPTIC [a] neurotransmitter RELEASE [b], POSTSYNAPTIC [a] neurotransmitter RECEPTION [b] is conceptually more straightforward since" (p. 260)	a. contrad-ictory/contrary opp. b. correlative/ reverse contrary opp.	Yes	Yes (motion, orient.)

Both antitheses are active in the context and belong to the spatial categories *motion* and *orientation* since PRESYNAPTIC/POSTSYNAPTIC are related to the genus 'time' (and time can be viewed as a linear path, a direction), and RELEASE/RECEPTION deals with 'movement' and 'direction' since the mechanism takes place between two synapses which are somehow related to each other in terms of distance. Antithesis [a] is a contradictory opposition since the comparison deals with states that are either before ('pre') or after ('post') the event (RELEASE/RECEPTION of transmitters). It is also a contrary opposition since time is a somewhat gradable entity. Even though [a] deals with a dichotomized time frame (an event is usually discussed as pre- *or* postsynaptic, never something in between), the time frame might generate a scale, to which one relates. Antithesis [b] is a reverse contrary opposition as well as a correlative because when a synapse releases transmitters, another corresponding synapse receives them.

These antitheses may enhance understanding on the same reasoning as in previous and coming excerpts (cf. Excerpt 9). Meanwhile, here, both [a] and [b] are active (and active processing might therefore take place more efficiently as opposed to if neither or only one of the antitheses were to be active).[126] These antitheses may enhance the understanding of the information and may as well increase the likelihood of the information to be remembered due the symmetry that the antitheses construct which could give the information a more forceful cogency. Furthermore, the overall picture is more completed due that A and NOT A are present, which may be interpreted in the same way as is a definition which thus heighten and make the molecular biological facts more clear to the receiver.[127]

Moreover, [a] and [b] belong to the same two sensorimotor domains which may have the potential of enhancing the bodily experience, upon which the information provided in the

[126] cf. page 16
[127] cf. pages 8, 10

excerpt (that the antithetical biological expressions explain the mechanism of neurotransmitter release and reception between the synapses) becomes easier to interpret, grasp and understand.

As mentioned above, a time frame is being projected in this excerpt, which can be found elsewhere (in Beutler (12), Rothman (37) or Greider (15)). Moreover, time can be interpreted as a linear path along which something is moving, which go in opposite directions – either backwards or forward (compare with a 'timeline', 'schedule' or 'running out of time'). Therefore, when a time perspective is related to an antithesis, it seems that the antithesis will at least be a contrary opposition (due to the gradability) as well as *orientation* (due to the linear path in space and the horizontal direction).

4.1.2. Excerpts 6 to 10: Bodily experience, active processing, 'scales' and 'cuts'

Excerpt 6

	Antithesis	**Sub-group**	**Active**	**Spatial**
11 12	"and quickly convert an EXTRACELLULAR [a] NEUROTRANSMITTER [b] signal into an INTRACELLULAR [a] IONIC [b] signal" (p. 260)	a. contrad-ictory opp. b. intermediate	Yes	a. Yes (space, orient.) b. No

Both antitheses are active and intrasentential and may enhance understanding in the same way as discussed in Excerpt 4 and 5. Only [a] is spatial, and seem to belong to *space* and *orientation* since EXTRACELLULAR/INTRACELLULAR explains where something is in relation to something else, inside ('intra') or outside ('extra') the cell. By contrast, [b] only describes if the signal is established by neurotransmitters or ions. Here, [a] is a contradictory opposition because it comprises two elements which are each other's direct opposites. It is a "cut". It is not a contrary opposition, although it could be interpreted as such since, in this context, neither the neurotransmitters from the outside nor the ions from the inside can be 'in between' – an interpretation a contrary opposition would allow for. On the other hand, to someone who does not have this kind of knowledge, the antithesis might be interpreted as a contrary opposition in terms of how something is oriented according to the cell. Thus, this dichotomization of [a] creates a dichotomy fallacy which generates misinterpretations and misunderstandings. Meanwhile, if familiar with biology, this fallacy would be ignored and would probably not cause any misunderstandings.

Antithesis [b] is an intermediate since NEUROTRANSMITTERS and IONIC SIGNALS do not necessarily have to be each other's opposites – however in this case, they are. This calls for a discussion regarding the endless antitheses which were to be elicited if all words in a sentence

always were to be viewed from different perspectives in order to allow them to be, at least once, an antithesis. From one perspective, any two elements could be an antithesis, if placed in a suitable context.[128] This is of course neither interesting nor relevant for understanding – we wish to realize the antitheses in close relation to subject matter. Moreover, we wish to realize the antitheses which could be constructive and which could help us understand and grasp the complex information given in the context. In this case NEUROTRANSMITTER/IONIC signals are each other's opposites, even though [b] comprises an intermediate. This is a noteworthy realization partly because the receiver might understand that different signals can be interpreted by the cell in different ways, and hence be converted into other messenger molecules, and partly because these signaling ways are important to the function of the synapses and the neurotransmitter release. Although all antitheses include some kind of uncertainties, intermediates are probably the most problematic, and it is therefore extremely relevant to let the receiver know what is A and NOT A. It seems that in such cases, NOT A is required to fully grasp the context. Because without NOT A, too many options are left for the receiver to decide about, which probably will leave her confused, with a vague overall picture of what is being presented.[129] For other intermediates like these, please view Yamanaka (antithesis 8: comprising BLOOD/HEART/BRAIN CELLS), Szostak (antithesis 6: PLASMID DNA/YEAST CHROMOSOME) and Barré-Sinoussi (antithesis 17: KEY DIFFERENCE (non-active)). Regarding [a], see similar antitheses in Hoffmann (antithesis 18 and 24: EXTRACELLULAR/ INTRACYTOPLASMATIC and EXTRACELLULAR/INTRACELLULAR respectively) as well as in Rothman (antithesis 7: EXTRACELLULAR/INTRACELLULAR).

Excerpt 7

	Antithesis	**Sub-group**	**Active**	**Spatial**
13	"The apparent SIMPLICITY of postsynaptic mechanisms, however, is deceptive because postsynaptic neurotransmitter receptors are subject to COMPLEX regulatory processes" (p. 260-61)	contrary/ contradictory opp.	Yes	No/Yes (orient.)

This active antithesis comprises contradictory and contrary opposites – it is both a 'scale' and a 'cut' since it comprises a gradable concept which also could be interpreted as binary. The antithesis describes what something is not ('not simple') even though it is being portrayed in that sense, hence by using an antithetical expression in the way Südhof does, he dissolves a possible misunderstanding regarding the postsynaptic mechanism. By being active, the

[128] cf. page 14
[129] cf. pages 8-10, 13-14

antithesis helps understanding, comparison and memory, as argued elsewhere.[130] But in terms of *orientation*, this example is somewhat different from the other excerpts presented above. This antithesis might not be gradable to the same extent to everybody because the dichotomization of SIMPLICITY/COMPLEX might be too strong, and therefore the antithesis is more easily interpreted as a contradictory opposition than a contrary one. If it, however, is interpreted as both, a visualization of a horizontal direction of a scale might be evoked, which may bring forth the memory of the very same bodily experience. Consequently, the information may become easier to grasp, interpret and understand since it can be related to the receiver's own body. A scale balances or weighs elements which is something our body does daily – no matter if it concerns the shopping bags in your fists or the seesaw on the playground. Antitheses like these – which first and foremost seem contradictory but are contrary as well – can also be found in Szostak (antithesis 16: MANY ARE RECOVERED/VERY FEW ARE RECOVERED), and Blackburn. In Blackburn, antithesis 37 is a part of the following excerpt which reads as follows: "the most striking properties of a telomere is how RESILIENT it can be TO MOLECULAR INSULTS of a variety of types, and then, like the last straw, just ONE MORE MOLECULAR CHANGE is SUFFICIENT for the telomere TO COLLAPSE catastrophically into disaster (p. 273)". It is contradictory opposite due the all-or-nothing-relationship: "molecular insults of a variety of types" and "just one more molecular change". Meanwhile, it is also a contrary opposition since the antithesis depicts how resilient the telomere is. However, as pointed out in the excerpt, eventually there will be a molecular insult that breaks the camel's back. This way of reasoning – starting from one molecular insult, to two, to three and so on, involves the gradable entity of 'amount', which makes the antithesis a contrary opposition. The contrary characteristic of the antithesis is important to realize, because otherwise, a very important characteristic of the telomere will risk go missing.

Excerpt 8

	Antithesis	**Sub-group**	**Active**	**Spatial**
14 **15** **16**	"I will DIVIDE neurotransmitter release into three processes, MEMBRANE FUSION as the BASIC mechanism [a_1] that mediates release by synaptic vesicle exocytosis, Ca^{2+}-TRIGGERING as the KEY event [a_2] that enabled fast synaptic transmission, and SPATIAL ORGANIZATION [a_3] of the RELEASE [b] machinery by the active zone that allows precise coupling of a PRESYNAPTIC [c] action potential to a POSTSYNAPTIC [c] REPSONSE [b]" (p. 264)	a. all three are intermediates b. correlative/ reverse contrary opp. c. contrad-ictory/contrary opp.	Yes	a. Yes (space) b,c. Yes (motion, orient.)

[130] cf. Excerpt 4 and 9.

In the excerpt above, [b] and [c] are antitheses which have been encountered before (c.f. Excerpt 5), and will not be discussed. Antithesis [a] is however new, and presents intermediates; three mechanisms that are distinctly divided from each other. By dividing these mechanisms, they become each other's opposites. Of course they might have many other corresponding opposites, but in this context, these are the only ones relevant to acknowledge – by introducing more, less important (neither "basic", nor a "key event") mechanisms, the information provided might be more difficult to grasp since the antitheses would not appear as evident, due to that the mind would have to distinguish between many options. Consequently, the mind would perhaps not respond to the antithetical elements in the same way as it may do when only two or three antitheses are provided, in a parallel, close proximity.

Because of this division, the different mechanisms outlined could be visualized as being put into different boxes or containers, and consequently, [a] belongs to *space*. They are separated from each other and might appear as each other's 'NOT A', and hence complement and make the overall picture more clear since the receiver may interpret the information as more defined facts (compared to as if only one or two mechanisms were presented) which are easier to grasp due symmetry that the antitheses provide, although they are intermediates. Since the division has the potential of evoking the cognitive, categorized image of [a_{1+2+3}], the receiver might find it easier to understand the information as the mechanisms explained can be related to and put into these imaged boxes. By separating the mechanisms, it is easier to compare them to each other, thus they become more active in the excerpt. Therefore, active processing might also take place more easily, which perhaps enhances understanding.[131]

Moreover, the sensorimotor domains provided by [b] and [c] will probably be put in relation to *space* as well, and thereby these interact with each other in the same way as was discussed along with Excerpt 2. That in turn, might create a stronger overall view of the explained mechanism of neurotransmitter release since the own body can relate to it in more, and different ways. Since the bodily experience of the mechanism is enhanced, the mechanism is easier to relate to, imagine and comprehend.

In addition to [c] (which was not discussed in Excerpt 5) the time frame – especially in a contradictory, oppositional way – might evoke the dichotomized picture of two 'time boxes', to which the receiver can relate to and 'put' the mechanisms in. Other molecular processes, correlated to the PRESYNAPTIC- and POSTSYNAPTIC-mechanisms, might then be categorized along with them – either they belong to the presynaptic time frame, or the postsynaptic time frame. If this takes place in the mind, time-correlated mechanisms could not

[131] cf. pages 15-16

only belong to *orientation*, but to *space* as well. Thus time-related antitheses could perhaps engage not only one, but two sensorimotor domains and thereby enhance understanding even more than an antithesis, entailing only one sensorimotor domain, would.

Excerpt 9

	Antithesis	**Sub-group**	**Active**	**Spatial**
17 18	"provided an immediate model for how SNARE proteins may mediate fusion, namely by ZIPPERING UP [a] in an N- TO C-TERMINAL DIRECTION [b], thereby forcing membranes that contain their C-terminal transmembrane regions into close proximity" (p. 266)	a. contrary/ reverse contrary opp. b. contrad- icatory/ contrary opp.	a.No b.Yes	a. Yes (motion, orient.) b. Yes (orient.)

This excerpt explains how SNARE proteins mediate fusion is explained by means of the antitheses, which the biological expressions entail. Antithesis [a] is implicit but stating that something is going 'up' implies that there could be an alternative of something going 'down'. Since the antithesis entails the gradable genus 'height', UP/DOWN constitutes a contrary opposition. However, [a] depicts a reverse contrary opposition as well due to the reversible relationship between the two states. Since [a] is in close correlation with a vertical direction, and owing to the implied movement (something is 'going' up), it belongs to both *orientation* and *motion*. Antithesis [b] on the other hand, entails the genus 'direction' and describes in what direction the 'zipper' is going. Since there is only either the N- or the C-TERMINAL (the endings) to a protein, it is a contradictory opposition, and since the terminals comprise a relation to one another, it is a correlative opposition. Because N- TERMINAL/C-TERMINAL deals with direction, the antithesis is *orientation*-related.

Both antitheses are spatial – thus, they may have the potential to evoke a visualization of what the mechanism in the excerpt looks like (an abstract structure in space). The receiver is able to relate to the information by means of this visualization that the antitheses may evoke on the premise of bodily experience. Since her body may already have experienced the very same spatial relations ('going up' the stairs, 'to zip up' a pair of jeans or walk from one place to another), provided by the sensorimotor domains, she can relate to the information and hence interpret and understand it in a more efficient way. Moreover, 'zippering up' does not necessarily mean 'closing'. When zippering up a tent, you open it. However, it does still involve vertical orientation. Consequently, by means of the comparison between the spatial conceptual antitheses and the memories of the corresponding, bodily experience, it is easier to 'see' and interpret the mechanism explained (for both the sender and the receiver). Moreover,

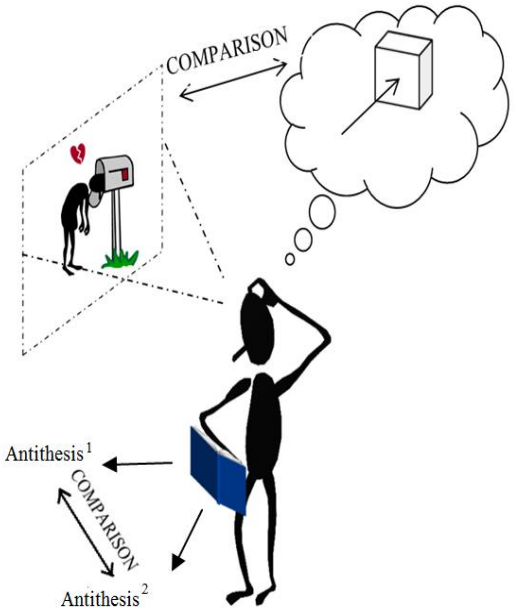

Figure 1. This schematic picture illustrates how the comparison between the image projected by the spatial conceptual antitheses and a memory of the same bodily experience by the interpreter of the text (sender or receiver) takes place: The antithesis in the text projects the horizontal movement of something going into a container (the arrow and the box). That is compared with a memory of the interpreter (here, head in letter box). Simultaneously, a comparison is taking place between the words that comprises antithetical element[1] and antithetical element[2]. Consequently, active processing occurs.

the experience might become more real and easier to grasp since the remembered self-experienced is compared to the imagined, same bodily experience evoked by the text.[132]

Additionally, it is the comparison between previous experience and the new, imagined experience, required for interpreting the visualizations (evoked by the spatial conceptual antitheses) that calls for memory; hence the memory of experienced bodily directional movement in space is used for interpreting the same bodily experience evoked by the text. Due to the comparison between the spatial, multidimensional visualization and the own body, active processing might become involved as well since the comparison calls for memory, reflection and digesting information – processes which are included in active processing. Active processing does however not only take place by means of the comparison between experienced and imagined bodily experience, but also by means of active antitheses (explicit antithetical elements which are in close relation in the text, either intrasententially or in parallel sentences).[133] Moreover, not only does one have to digest the active antithesis on a lexical level, but on a cognitive level as well (see Figure 1).

Only [b] is active, which means that both antithetical elements, comprising the antithesis, are in relation to each other – either intrasententially or in parallel sentences. Due to that they are active, they stand out from the rest of the words and might therefore be easier to remember as well as compare, by means of active processing.[134] Owing to the antithetical elements' close relation in text, and because the mind is forced to recall what was recently read, the mind might become more alert to the opposition the antithesis create. Thereby, the comparison taking place might become stronger, upon which the information perhaps is more

[132] cf. pages 15-18
[133] cf. pages 16-18
[134] cf. pages 8, 10, 16

easily remembered. By contrast [a], which is not active, might not be as easily remembered because the same strong comparison cannot take place. Antithesis [a], nevertheless, comprises two spatial sensorimotor domains which [b] does not. A combination of two or more spatial categories might enhance understanding even more due to that the bodily experience becomes much stronger since – in [a] – not only is a vertical direction involved, but so is movement (something is 'going' up), a movement that involves the own body even more. It is not only being compared to the vertical line in space, but the body is simultaneously moving along with it. Regarding more than one spatial category, the same phenomenon can be viewed at least once in each and every one of the lectures, see appendix (apart from many of the following excerpts).

Before moving on to the next excerpt, it is important to acknowledge the metaphorical elements, found in the very same words and expressions which are interpreted as antitheses. As pointed out on pages xx, expressions or words that seem to be conceptual metaphors, might as well be founded on conceptual antitheses just as much. For instance, "zippering UP" could be interpreted metaphorically, evoking an image of what the mechanism 'looks like' or how the molecules behave. But, if it is interpreted as an antithesis, more information is provided – partly on the basis of bodily experience and partly on a lexical level. The metaphorical image does not involve bodily experience (by means of spatial sensorimotor domains) as much as the antithetical image does, nor do the metaphors provide comparison in the same explicit way. Additionally, the metaphorical image does not seem to engage memory (which probably is important to interpretation and understanding[135]) as much since the comparative element is implicit and might not be as evident to mind as the comparative element of an antithetical pair is. Meanwhile, without the metaphorical character of the antithetical expression, the antithesis would not be of much use to the understanding.

Excerpt 10

	Antithesis	**Sub-group**	**Active**	**Spatial**
19	"yeast Sec1p binds to assembled SNARE complexes and acts DOWNSTREAM of SNARE-complex assembly" (p. 267)	contradictory/ contrary opp.	No	Yes (orient.)

This excerpt presents a contradictory and a contrary opposition, which (in this context) describes where a gene is located on DNA or where a molecular mechanism is taking place: yeast Sec1p (a protein) acts downstream of SNARE-complex assembly. It is contradictory due

[135] cf. pages 15-16

to its either-or-relationship (either UPSTREAM or DOWNSTREAM, there is no 'in between' state). It is contrary due to the gradability of UP/DOWN.

The antithetical element is not active but by stating that yeast Sec1p acts "DOWNSTREAM of", it implies that something could act 'upstream' as well. The antithetical pair DOWNSTREAM (behind, depending on the orientation of DNA) and (here implicit) UPSTREAM (in front of) are used as orientation on DNA. In this case, a mechanism takes place behind a specific position of DNA. Because of this abstract linear DNA, and the fact that UP/DOWN can be put on a gradable, linear scale, this opposition belongs to *orientation*. If the opposite of DOWNSTREAM would have been used, it would have been a very strong antithetical pair since UPSTREAM/DOWNSTREAM not only is antithetical lexically, but conceptually as well. However, it might not always be relevant to mention the corresponding antithetical element. Meanwhile, if there is a mechanism worth mentioning that takes place UPSTREAM, it would probably be wise to mention it parallel to DOWNSTREAM. Then there would be an active antithesis instead, which could lead to active processing – a process that seem beneficial to understanding. Moreover, the antithesis would be more spatial since the horizontal directions of DNA would perhaps have become more apparent to the receiver. Lastly, the excerpt would provide more information to the receiver, who then might have understood that, not only is the gene itself important, but so is what happens 'behind' and/or 'in front of' it, and that there could be essential mechanisms taking place in relation to, but far away from the gene. A very similar example is antithesis 23 in Hoffmann.

4.1.3. Excerpts 11 to 14: Dichotomy fallacies and predicting misunderstandings

Excerpt 11

	Antithesis	**Sub-group**	**Active**	**Spatial**
20 21	"an exocytosis-SPECIFIC [a] binding mode in which Munc18-1 binds to *'*CLOSED*'* [b] Syntaxin-1 independent of the N-peptide, and a GENERAL [a] binding mode shred with some other SM protein/SNARE complex interactions in which Munc18-1 binds to *'*OPEN*'* [b]" (p. 270-71)	a. contrad-ictory opp. b. contrad-ictory/ reverse contrary opp.	Yes	a. No b. Yes (motion)

Both antitheses above are active and comprise contradictory opposites (something is either GENERAL or SPECIFIC, either OPEN or CLOSED). Only [b] comprises a reverse contrary opposition – OPEN and CLOSED – which describes the 'either-or-states' of the complex "Syntaxin-1". Due contrariety, the antithesis may appear gradable although it is not – the complex is either open or closed. Yet, in a general context, [b] could be a gradable entity, and since no information is provided which emphasize this dichotomous behavior of the complex,

the receiver could believe that there is gradability of [b]. Consequently, this increases the risk of misinterpretations and spreading pseudoscientific information.

In comparison to [a], [b] is spatial since it comprises movement and therefore belongs to *motion*. It seems to be quite dependent on the structure of conventional antithesis – without CLOSED being the opposite to OPEN and vice versa, the *motion* the expression may evoke would perhaps not be as distinct. Meanwhile, since the antithesis OPEN/CLOSED also has the potential of being understood as states (which they depict), the bodily experience of the movement might not appear as particularly strong. Hence, when a contradictory opposition is mixed with a contrary, the movement that the antithesis may depict, is not as striking due that the contradictory perspective makes a 'cut' whilst the contrary is more moving owing to 'scale'. This could also be seen elsewhere in the analysis, however not enough times to make it a significant observation.[136]

Another matter to discuss, which is encountered in antithesis 12 as well, is whether an antithesis that is spatial could 'help' another one which is non-spatial to be understood as such. Contradictory opposition, as well as antitheses in close relation, seems to be more evident to mind.[137] Hence, the mind might couple two antithetical elements together as one, and therefore partly interpret a non-spatial antithesis as spatial. In this case, the SPECIFIC binding might be coupled with CLOSED, whereas the GENERAL binding might be coupled with OPEN, and as a result, [a] might too be correlated to *motion*. In Excerpt 6 then, the spatial antithesis EXTRACELLULAR/INTRACELLULAR might be coupled with the non-spatial pair, NEUROTRANSMITTER/IONIC signal, and thus [b] might be correlated to *space* and *orientation*. If this 'coupling-process' takes place, it could enhance understanding even more since both antitheses would allow for an interpretation that includes bodily experience – which indeed favors interpretation and grasping information since it includes comparison, and memorization – processes which are believed to be essential in order to understand.[138]

Excerpt 12

	Antithesis	**Sub-group**	**Active**	**Spatial**
22 **23**	"Synaptobrevin-2 and Syntaxin-1 still mediate fusion when both are attached to their resident membranes via lipid anchors, NOT TRANSMEMBRANE REGIONS [a], demonstrating that SNARE TRANSMEMBRANE REGIONS [a] are not essential components of the fusion machine. These results support the notion that SNARE proteins act AS FORCE GENERATORS [b], and that their transmembrane regions do not act as FUSION CATALYSTS [b]" (p. 272)	a. contrad-ictory opp. b. contrad-ictory opp./ intermediates	Yes	a. Yes (orient.) b. Yes (motion)

[136] Compare antithesis 21 with 11, 13 for instance.
[137] cf. pages 8, 10, 12
[138] cf. pages 15-16

In Excerpt 12 above, where Südhof explains how fusion between a vesicle and a synapse is mediated and how SNARE works in the mechanism, both antitheses are active. Antithesis [a] (a biological expression) has NOT in front of the one of the antithetical elements comprising the pair which makes it a contradictory opposition. This also applies for [b]. It belongs to the sensorimotor domain *orientation* since it describes how the proteins are attached to the cell membrane (TRANS means 'across', lat., and across, in this case, deals with a vertical direction). Antithesis [b] is not only a contradictory opposition, but entails a intermediate opposition as well, since it explains on the one hand what SNARE proteins do (generates force) and on the other, what they do not, but not in relation to generating force. It belongs to *motion* since it is related to FORCE.

Since both antitheses are active they may also enhance understanding by creating symmetry, which leads to the impression of a better overall picture (as argued elsewhere).[139] The receiver may also thereby have a better chance of remembering the provided information; and by means of: engaging memory as well as active processing. When the second antithetical element of the pair is encountered, it is compared to the previous, and hence the receiver has to compare and reflect upon what was recently read. In this case, the receiver might reflect upon what the SNARE proteins do and do not and therefore digest this information more thoroughly. By contrast, if one of the oppositions of the pair would be implicit then this process would not be as evident (as in Excerpt 9, antithesis [a]) and therefore would not enhance understanding, or memorization, as much as it would have if the antithesis is active. In summary, by having active antitheses, memory is engaged by means of the comparative element of the active antithetical pair.[140]

Both antitheses in this excerpt are spatial in one way or another, which may promote understanding since their spatial character can be compared with bodily experience (which is suggested to make understanding more efficient since the body can be used as a medium to compare information to, if presented by means of spatial concepts).[141]

Excerpt 13

	Antithesis	**Sub-group**	**Active**	**Spatial**
24	"fire action potentials often in BURSTS or TRAINS" (p. 273)	contradictory opp.	Yes	Yes (motion, orient.)

[139] cf. page 10
[140] cf. pages 8-10
[141] cf. pages 16-18

In this excerpt, the action potentials are described in terms of the antithesis BURSTS/TRAINS; there is either one big action potential (a 'burst') or many action potentials (i.e. 'trains') that, altogether, corresponds to the impact of a big one. The dichotomous character of the action potential is hereby being described in terms of *motion*, but *orientation* as well since the action potentials must go in some kind of direction, e.g. forward. Since only two options are given, of how the action potentials behave, the antithesis is a contradictory opposition, and because the antithetical pair is explicitly in close relation to each other, it is also active. As stated in previous excerpts, an active, multi-spatial conceptual antithesis helps understanding due to active processing (lexically and cognitively, see figure 1) as does an active antithesis (although it may be "local").[142] Active processing is involved in the comparison between the antithetical elements comprising the pair, as well as in the comparison between the imaginative visualization and the bodily experience. Both of these cases force memory to compare old experience to new one.[143] Moreover, the bodily experience, evoked by the sensorimotor domains that are imagined due to the antithesis, can be related to either a vertical or a horizontal directional movement. The experience helps understanding since the information becomes easier to relate to, to interpret and to visualize. A similar example can be found in Rothman (20).

Excerpt 14

	Antithesis	**Sub-group**	**Active**	**Spatial**
25	"event involves the FOLDING and UNFOLDING of reactive SNARE proteins, exposing the presynaptic" (p. 273)	contradictory/ reverse contrary opp.	Yes	Yes (motion, orient.)

This antithesis presents a reversible either-or-case since the SNARE proteins can 'fold' and 'unfold', and therefore involves both a contradictory and a reverse contrary opposition. The mechanism is described in terms of *motion*, but the antithesis could also belong to *orientation* since these SNARE proteins fold and receive their shape in a horizontal or vertical direction. However, if the receiver is not familiar with how proteins manage to bend and create their destined shape, she might only interpret 'fold' and 'unfold' as bending something and straightening it out again (like a pocket knife). The antithesis would still belong to *orientation* but the picture would perhaps not correspond to how proteins are considered to behave. Actually, any protein can be semi-folded, and in such a case it either works poorly or not at

[142] cf. page 14
[143] cf. page 15

all. Due to the dichotomization of the antithetical pair, such information is omitted.[144] In this context, however, this is but a detail, and is not a piece of key information required to understand the overall picture. Meanwhile, as a matter of principle, contradictory oppositions should be used carefully, since a biological expression, conveyed in a dichotomized way, can create a dichotomy fallacy. Such fallacies might lead to an inadequate interpretation of the biological mechanisms, and if communicated, might lead to pseudoscientific information. Fortunately, Südhof is, once again (as in Excerpt 7), well aware of this risk (cf. Excerpt 15).

The antithesis might enhance understanding by means of the comparative element of active processing between the antithetical elements and between the memorization of bodily experience and the visualized image of how the proteins move in space (evoked by the antithesis FOLDING/UNFOLDING, which probably projects a directional, moving image). Furthermore, since the antithesis is active it might be more evident to the receiver and hence more thought of. The antithesis also involves spatial qualities, which makes it easier to relate to, visualize and grasp by means of comparison to the own bodily experience (FOLDING/UNFOLDING can be compared with SITTING DOWN/STANDING UP or SITTING UP/LYING DOWN). It may also increase understanding due the active antithesis which, as mentioned before, creates a greater symmetry. This might help the receiver to grasp the information since the oppositions probably will complement the overall picture of what biological process that is described, and by using the active antithesis, the definition of how the SNARE protein behaves is much clearer. In this way, the information may also become less vague and more easily grasped since the 'definition' makes the information clearer due increased completeness.

4.1.4. Excerpts 15 to 19: Contradictory *and* contrary opposites, non-active *and* non-spatial antithesis

Excerpt 15

	Antithesis	**Sub-group**	**Active**	**Spatial**
26 **27**	"PROPER FOLDING [a] of SNAP-25, rendering SNAP-25 COMPETENT [b] for SNARE-complex assembly. In CSP αKO mice, MISFOLDING [a] of SNAP-25 IMPAIRED [b] SNARE-complex assembly" (p. 273)	contradictory/ contrary opp.	Yes	a. Yes (motion, orient.) b. Yes (orient.)

The active antitheses 26 and 27 present what was previously discussed – a protein does not only fold and unfold, but may also become semi-folded or, as in this case, 'misfolded', and create an 'impaired protein' which does not function properly.

[144] cf. page 12

This excerpt describes how the folding of SNAP-25 (PROPER or MIS-) affects the SNARE-complex which is either COMPETENT or IMPAIRED. These are contradictory antitheses because they describe either-or-relationships. They are also contrary since how 'well' folded SNAP-25 is, comprises a gradable concept – hence, the antithesis can also be put on an abstract linear scale.[145] The same applies if SNAP-25 is COMPETENT or IMPAIRED (most of the time a protein has to be properly folded in order to function, but non-properly folded proteins could also function, just not as well). Both antitheses are active and spatial. Antithesis [a] belongs to *motion* (folding is a movement, as explained and discussed in Excerpt 14), and both antitheses belong to *orientation* due to the linear scale, visualized since the antithetical pairs involves gradable expressions.

Since both are active, they may enhance understanding as have been discussed in excerpts above.[146] These too seem to relate on the structure of antithesis, which without the sensorimotor domains would perhaps not be as evident (if they are related to at all).

An observation that has yet not been discussed is the constructiveness of an antithesis that entails both a contradictory *and* a contrary opposition.[147] Biology is a discipline that entails lots of exceptions as well as schematized concepts since it is such a complex science. Using antitheses that comprise not only contradictory but contrary oppositions too might allow for a more efficient understanding as well as and a more accurate interpretation of the information. When allowing for multiple options (which accompanies gradability), the complex world of biology is emphasized. Meanwhile, thanks to dichotomized explanations (which the contradictory opposition provides) the information might be easier to grasp for the same reason that applies to active antithesis. Since a contradictory opposition seems to have the potential of bringing forth the antithesis in a more clear-cut manner, compared to other antitheses such as contrary oppositions and intermediates which allow for a less evident antithetical comparisons, it might benefit efficient understanding.

Excerpt 16

	Antithesis	**Sub-group**	**Active**	**Spatial**
28	"ATP-DEPENDENT chaperone (…) ATP-INDEPENDENT chaperone" (p. 273)	contradictory opp.	No	No

Evidently, this is a contradictory opposition since it consists of two expressions in direct opposition to one another. Either the chaperone is depended on ATP (cellular energy) or not.

[145] cf. pages 12, 25
[146] cf. Excerpt 5 or 9
[147] I have however discussed antitheses comprising both, cf. antithesis 20 in Excerpt 11.

It is non-active due to a relatively great distance between the antithetical elements. Furthermore, the antithesis is not spatial since DEPENDENT/INDEPENDENT cannot (as I interpret it) be related to direction, movement or containers. How does this influence the interpretation and understanding of the information? That is of course an unanswerable question – at least in the present study – however, it is still possible to discuss the matter. Due to the big distance between the antithetical expressions, and due to the difficulty of relating them to bodily experience, the information provided in the text is probably not as easy to visualize, nor compare, as if the antithesis would have been more active and in terms of what could be related to the sensorimotor domains. If the contradictory opposition is acknowledged by the receiver, it might help create the picture of what the text says. In this context, the text surrounding the antithesis is filled with biological expressions and 'strange' words inter alia "CSPα", "DNA-J domain", "Hsc70 and the tetratricopeptide-repeat protein SGT". In contexts like these, antitheses that are spatial would have been helpful since they provide dimensions to which one can compare the own body.

Excerpt 17

	Antithesis	**Sub-group**	**Active**	**Spatial**
29	"loops emerging from the TOP and BOTTOM" (p. 275)	contrary/contradictory opp.	Yes	Yes (orient.)

This antithesis is active and comprises a contrary opposition since it involves the gradable concept of 'height' (as did Excerpt 10). Moreover, the antithesis also involves a somewhat contradictory opposition since TOP/BOTTOM are, in this context, each other's direct oppositions. The argument for Excerpt 10, applies here as well.

Excerpt 18

	Antithesis	**Sub-group**	**Active**	**Spatial**
30	"we observed that although FAST release was ablated in Syt1-deficient synapses, a SLOWER form of Ca^{2+} triggered release remained" (p. 281)	contrary opp.	Yes	Yes (motion, orient.)

This active antithetical pair, FAST/SLOWER (an antithesis that was also encountered in Excerpt 4) can be put on a linear scale, due the genus 'speed' being a gradable entity, hence the antithesis is contrary and therefore belongs to *orientation.* What was argued in relation to Excerpt 4 applies here as well.

Excerpt 19

	Antithesis	Sub-group	Active	Spatial
31 **32**	"The CENTRAL [a] complexin α-helix that is bound to the SNARE complex is essential for ALL [b] complexin function. The ACCESSORY [a] α-helix is required ONLY [b] for the clamping BUT NOT [b] the activating function of complexin, demonstrating that clamping is not a prerequisite for the activation function of complexin" (p. 288)	a. contrad-ictory/ corre-lative opp. b. contrad-ictory opp./intermed-iates	Yes	a. Yes (space, orient.) b. No

These are active antitheses. Antithesis [a] is a contradictory (either-or-relationship) and a correlative (a relation, similar to CHILD/PARENT) opposition that describes the helix, being either CENTRAL or ACCESSORY in relation to the SNARE complex. The second antithesis, encountered in the excerpt, [b], is however contradictory in the sense that when the helix is CENTRAL, the SNARE complex is essential for all complexin functions, but when it is ACCESSORY, it is only required for the clamping of complexin. One of the oppositions of [b] also makes it an intermediate in the sense that the first antithetical element of the pair entails 'all functions' – functions, which never are conveyed. However, it is not important to know all complexin functions in this context, and therefore the intermediate does not matter. Due to the first antithetical element (ALL), the next seem more evident (ONLY) since they are each other's direct opposites. Owing to this antithesis, a more important fact might be grasped from the excerpt, namely that the "accessory α-helix" is only important for the clamping BUT NOT for the activating function – a conclusion that is significant for the understanding of the function of complexin.

Antithesis [b] is not spatial. However [a] is, in terms of *space* and *orientation* since whether the complexin α-helix is 'central' (or not) or 'accessory' (or not) may create a visualization of how the different parts of the SNARE complex relate to one another as containers. Furthermore, the complexin α-helix also relates to the complex in some direction – hence *orientation*. As in many of the excerpts above (which entails more than one sensorimotor domain), when more than one spatial category is involved the potential of enhancing the understanding increases. This might be the case because when more than one dimension in space is involved in the interpretation and visualization of what is being read, the bodily experience increases. It does so by means of there being more sensorimotor domains to relate to, compare with and use during memorization.[148]

[148] cf. Excerpt 3

4.2. In all lectures

In all lectures, most antitheses seem to appear in clusters – they mostly appear in groups and in correlation to the molecular biological subject matter discussed. They did not appear as often in the personal anecdotes or in between the molecular mechanisms being explained, where some kind of story-telling took place in the text. I did however not pay much attention to these parts of each text, and therefore this has to be further studied somewhere else in order to give a good analysis.

It is worth pointing out that there are many biology-related expressions across all lectures that are contradictory oppositions. It is difficult to find any pattern among them. However, as stated on page 13, contradictory oppositions seem to be a part of our everyday life and thus seem to shape our minds and our ways of thinking and define different elements accordingly. Many phenomena within molecular biology come across as contradictory, or at least many mechanisms evolve around contradictory oppositions – such as EXTRA-/INTRACELLULAR, C-/N-TERMINAL, LEADING/LAGGING STRAND, ENDOCRINE/EXOCRINE and OUTER/INNER MEMBRANE. Meanwhile, it is man who has named these mechanisms, and it is man who has interpreted them this way. Moreover, it is worth noting that most contradictory oppositions are spatial. This might enhance understanding, since contradictory opposition seem more evident to the mind and can therefore be realized much faster. An intermediate, on the other, would perhaps not since it usually appear as quite vague (cf. antithesis 12 in Hoffmann). Contradictory oppositions also seem to enhance active processing as explained elsewhere (page xx).

Lastly, a common quality among the excerpts across all lectures is that many antitheses appear together in one paragraph and intrasententially. Since many antitheses are involved, such a paragraph would maybe be easier to understand due to spatial conceptual antitheses together, create a strong, visualized image. Such a paragraph could perhaps enhance understanding in the same way as an alone, active antithesis that includes all three sensorimotor domains, seems to do. In both cases all sensorimotor domains are included which may result in the same the bodily experience. In the first case, however, there are many antitheses, together presenting the sensorimotor domains, whereas in the second case, there is only *one* antithesis, present all three by itself. In fact, an excerpt that entails many antitheses (where most of them are active and spatial) might be better for understanding than an alone one. In such an excerpt, the lonely antithesis is surrounded by words, concepts and such, which are not antithetical in character and therefore make the information less clear due to

lack of many spatial conceptual antithesis (cf. Excerpt 2 in the analysis (where all oppositions are spatial but none is active) with antithesis 25 in Greider (which comprise just one single antithesis, but can however be correlated with all three sensorimotor domains)).

4.3. Only, or not at all in Südhof

Südhof is paradoxically unique. On the one hand, Südhof's lecture comprised all different kinds of antitheses, oppositions and combinations – which was why it was chosen to be the representative text in this study. On the other hand, this quality is what makes Südhof non-unique, since generally, the lecture does not show any unique antithetical elements, hence the paradox.

The other lectures however, present qualities and antithetical elements, exclusive (or almost exclusive) for that particular lecture. First of all, the lectures from which I elicited the lowest number of antitheses was Yamanaka. However, he discussed how he discovered that mature cells can be reprogrammed to pluripotent cells, i.e. cells that can become any kind of cell which entails a lot of story-telling instead of explaining molecular mechanisms in detail (as did most of the other lectures especially those concerning, telomeres and neurotransmitter transport). Yamanaka's lecture did entail this too, but not to the same extent. Hence, according to the analysis of this case study, antitheses were more often encountered in correlation with molecular mechanisms being described and explained. In comparison, when molecular mechanisms were not the focus of the lecture but instead how the Nobel Prize laureate discovered what was discovered, antitheses occurred less frequently. This does however not say much about understanding and subject matter. Nevertheless, the observation states that antitheses are used more often in contexts where the information is more difficult to understand, compared with contexts where the information concerns how something was discovered. Furthermore, it states that more obvious antitheses are used (i.e. active) when the subject matter is more complex (as in scientific language). By contrast, less obvious antitheses are used when 'everyday' language is mainly used.

Now, more detailed examples shall be discussed. Szostak's lecture is the only one that comprises an antithetical title (which might allude Churchill's speech "the End of the Beginning"): "DNA ENDS: Just the BEGINNING". Even though ENDS deals with DNA and BEGINNING deals with a time-related, linguistic expression, they are still an antithetical pair. It is a contradictory opposition because it comprises END/BEGINNING, antithetical elements which are each other's direct opposites. The antithesis is categorized as belonging to both *orientation* and *motion* since the expressions involves: 1) DNA is as a structure (which is

linear, hence *orientation*); and 2) time (which can be interpreted as both a linear concept and something that is moving).

Greider is unique in the sense that she, in antithesis 21, explicitly states that Blackburn and herself did the direct opposite of what Szostak and Blackburn did. This excerpt does not, per se, entail an active antithesis (but is actually more of an antithesis) – it is however antithetical in the way it is formulated:

> The final experiment that convinced both Liz and me that we had something new was when we did the correlative of the experiment that Liz and Jack Szostak had done, which had been published in Cell in 1982. They had put Tetrahymena telomeres into yeast cells and shown that a yeast telomeric sequence was added to the ends. By contrast, we made a synthetic yeast sequence telomere oligonucleotide primer and put it in Tetrahymena extracts – and found that the Tetrahymena telomere repeats were added to the yeast telomere. (p. 308)

Not only does this antithesis present what was done by Greider and Blackburn and Blackburn and Szostak, respectively, but it also presents what can be discovered if 'the opposite' is done. This excerpt entails an active antithetical element that is a contradictory opposition. It is however not spatial. Meanwhile, owing to the contradictory character of the excerpt, the understanding might be enhanced by means of active processing, comparison and the active character – as explained elsewhere (cf. Excerpt 9).

Both Rothman and Szostak discuss 'cycles' - the "BINDING-RELEASE-cycle" (antithesis 31: How ATP (cellular energy) binds and releases from different molecules) and the "BREAKAGE-FUSION-bridge-cycle" (antithesis 2: How broken chromosomes are fused together again after replication). These are reverse contrary oppositions that entail entire molecular mechanisms. They are concepts, entirely built on a reverse contrary oppositional character. Hence it is likely that mechanisms which are discussed in relation with these are reversible, oppositional in some way as well. This might indeed lead to a more efficient understanding, since if the receiver grasps the principle of the basic reverse contrary opposition, other related mechanisms may be easier to interpret and understand as well.

These antitheses belong to *motion* because they depict movement, with which we are familiar. If these expressions' antithetical elements, BINDING/RELEASE and BREAKAGE/FUSION, are separated and if mechanisms related to the different four expressions are categorized accordingly, the antithetical concept as a whole could also belong to *space* since correlated mechanisms can be 'put' into different boxes or containers. For instance, in the case of Rothman, antithesis 32 (ASSEMBLY/DISASSEMBLY) is correlated to BINDING/RELEASE.

Lastly, it seems relevant to mention antitheses such as 15 in Hoffman, 11 and 12 in Rothman, 10, 11 and 12 in Szostak, and 2 in Greider. The common denominator among these is a method called ‘gel electrophoresis’. This is a very interesting since it is, more or less, based on antithesis. Gel electrophoresis is used when substrates (protein, RNA or DNA) are to be separated from each other. The results show the separation, by which the substrates can be defined and categorized, mostly, according to size. Even the results (viewed as ‘bands’) can be antithetical in character – some bands are BLURRY and others are SHARP instead (Greider (2)). By employing this method, antithesis is used in order to interpret, grasp and understand how different substrates differ from one another. If the bands or the substrates are discussed as ‘walking in the gel’, spatial relations are used as well. The important point here, however, is that the gel electrophoresis, when used, is based on antithesis. It might enhance understanding, either by its contradictory character – showing very clear distinctive bands (or not) – or by the movement in the gel, hence comprising sensorimotor domains (*orientation* as well as *motion*, since the substrates are moving in a direction), which might have the potential of enhancing understanding due to a possible comparison with bodily experience (as argued elsewhere, cf. Excerpt 4-6, 9 for instance).

5. Discussion and conclusions

Approximately two thousand years ago, Aristotle, Quintilian and many other rhetoricians talked about antithesis as a figurative element in language. Over a hundred years ago, Bain claimed antithesis to be an essential cognitive, rhetorical figure used to understand and comprehended the world in which we live. During the past years, there has been more research on antithesis and the oppositions that antithesis entails – not only because they may be part of our everyday lives, but also since they may influence understanding.

By analyzing ten Nobel Prize Lectures in Physiology and Medicine, and focusing on one in particular (*The Molecular Machinery of Neurotransmitter Release* by Südhof), I tried to explore whether antithesis could contribute to a more efficient understanding of complex information. The purpose of the study was to explore whether using antithesis as a cognitive rhetorical tool, may generate a more efficient understanding of abstract information as a step towards making molecular biology students become better at communicating science. The overarching research question has been: In what ways is antithesis found in the empirical data and how may antithesis be correlated to understanding?

5.1. Antithesis and understanding: Could they be interrelated?

Generally, the analysis shows that antithesis may contribute to an enhanced understanding of complex information if the antithesis is active. If it really has to be spatial conceptual will be discussed below. The analysis does not present unanimous results, since it also shows that an antithesis could help understanding even though it might only be active or only spatial – as in antithesis 17 and 2, 3 respectively.

5.1.1. Active or not?

Most antitheses were active (See Appendix 2, Table 2 and Figure 3), which seems to influence and perhaps enhance understanding – but not on the same premises as for spatial conceptual antithesis. Just like the spatial ones, active antitheses also seem to call for memory, comparison and active processing (as discussed in relation to Excerpt 9, 12 and 13 for instance).

In this analysis, when two oppositions, comprising an antithetical pair, are in close relation in the text, the pair seems to become more apparent to the receiver as if compared to when the corresponding antithetical element is intersentential and far away from the other (cf. comparison between antitheses 17 and 18). When the two antithetical elements are realized by the receiver, she is forced to call for memory as well as for comparison since, in order to

realize the pair, the second antithetical element encountered must be compared to the first one, which hence is remembered and reflected upon (to what extent is however unknown). Moreover, an active antithesis excludes possible genera which the receiver could consider as well if the antithesis was to be non-active. When being explicit, the rhetorical device seems to adjust the focus to the difference of two elements common genus, upon which then might enhance the *res* that the antithesis brings forth. In summary, an active antithesis (if not comprising a "local" antithesis) seems more evident and might therefore make the provided complex information more accessible to mind.[149]

However there are cases when the antithesis is implicit and where only one of the oppositions may be required for the context since its opposite is evident. The non-active antitheses do not necessarily have to be less efficient for understanding as an active one. Recall Excerpt 2 for instance. If a paragraph, only comprising non-active antitheses, is complemented with each antithetical element's corresponding opposition, unnecessary information is given to the receiver who perhaps gets confused. In some contexts, non-active antithetical expressions are enough. Thus NOT A is not always important, but can be superfluous instead. But when can NOT A be excluded from the context? When is it appropriate? When does the clarifying character of the antithesis remain intact when one of the opposites is absent? This makes the implicit antithesis problematic. Moreover, is an implicit antithesis actually an antithesis? According to Lausberg, the oppositional elements that the antithesis entails could be "two *res* of contrasting content"[150] , and whether the content is explicitly put or not is not emphasized. However, cola – which is a quite important characteristic of the syntactic perspective on antithesis – seems to be missing when one of the oppositions, comprising the antithesis is implicit. Perhaps, an implicit antithesis could be regarded as an antithesis if it is recognized by the receiver and by context. This should also apply for an antithesis, comprising two oppositional terms which do not seem oppositions to a general audience, such as antithesis 3, 6 or 18.

By contrast, the active antithesis seems to exclude possible oppositional alternatives owing to its clarifying character (e.g. if the oppositions are conventional – otherwise they may not appear as active, cf. antithesis 12). In the case of dichotomized expressions (those that entail contradictory opposites) as presented in the following section), the antithesis and what opposition it comprises, might define 'what is and what is not' to the receiver in a more efficient manner. By means of active antitheses one is saying what something is as well as

[149] cf. pages 8-10
[150] cf. page 1

what something is not, and if being as clear as possible (i.e. defining), understanding might become enhanced.[151] Consequently, the conveyed information might be easier to grasp since the antithesis could appear as a definition, which in itself may make information more evident and easier to grasp due the clarity that definitions often result in.

Meanwhile, when defining something in this way – by means of a dichotomized antithesis – there is of course a risk of simplifying information too much which might create pseudoscience. Therefore, one should always think twice before explaining, say a molecular mechanism, to laymen or to anybody who do not possess the same expertise on the subject matter. If the active antithesis is likely to be a dichotomy fallacy, it should be avoided, and if not possible, then it should be discussed (cf. Südhof in Excerpt 14 and 15).

5.1.2. Multiple oppositions

All sub-groups in Table A were encountered in the analysis: the contradictory, contrary, reverse contrary, correlative oppositions and intermediates. In general, however, the antitheses were not only categorized as merely one sub-group, e.g. for instance Excerpt 13, but mostly two, and sometimes even three (cf. Excerpt 3) – probably due to that most biological mechanisms brought up in the excerpt can be regarded from more than one perspective. The contradictory opposition is by far the most common one, followed by contrary opposition, hence the results in this study do not entirely agree with Aristotle.[152] Intermediates, correlative and reverse contrary oppositions were not used as frequently (see Appendix 2, Table 2 and Figure 4). Meanwhile, it is important to keep in mind that there might be a correlation between the subject matter and the antitheses used – when discussing 'cell relations' and molecular mechanisms in detail, it might be more common to use correlative and reverse contrary oppositions – these were mostly used in Rothman and Südhof, who both discuss the transport of neurotransmitters in vesicles, a mechanisms that takes place *between* cells and where the relation between molecular processes are being explained thoroughly. By contrast, no reverse contrary or correlative oppositions are found in Yamanaka who is talking about the road to how he discovered that mature cells can be reprogrammed to become pluripotent cells. This lecture entails a lot more telling than explaining molecular mechanisms. Moreover, this implies that antithesis, as rhetorical device, seems to be part of *ordo naturalis*.

Interestingly, many biological expressions seem to belong to contradictory oppositions

[151] cf. pages 8-9
[152] cf. page 13

in a dichotomous manner. Such expression would be C-TERMINAL/N-TERMINAL for instance, PRESYNAPTIC/POSTSYNAPTIC, or perhaps EXOCYTOSIS/EDOCYTOSIS, as well as EXTRACELLULAR/INTRACELLULAR, FOLDING/UNFOLDING and ATP-DEPENDENT/ATP-INDEPENDENT. It is interesting since, when we put on a pair of glasses that allows us to see the antitheses, we realize that biological information is full of them. Why many biological expressions probably entail contradictory oppositions, is not answered within the scope of this research. But, speculating, it might be due to that contradictory oppositions put the complex information in the most clear-cut way, since such a distinction is more readily comprehended. In these cases antithesis does not only seem to be a figurative device, but seems to contribute to and create a molecular biological language within which the receiver might understand biological concepts on the basis of antithesis. The antithesis might therefore belong both to *elocutio and inventio* – it can be both of *ordo artificialis and naturalis*.[153]

There seems to be quite a thin line regarding whether a contradictory opposition creates a clarifying, dichotomous picture, or creates a dichotomy fallacy. Most of the time, a contradictory opposition generates a more efficient understanding since it 'pulls the antithetical elements in opposite directions' (and might enhance the effect of the antithesis being active as well). Consequently, the information seems clearer and is therefore easier to interpret and understand. However, there are cases when the dichotomous character is not as efficient. In the case of HPV-POSITIVE/HPV-NEGATIVE, presented in Hausen's lecture, this creates a false dichotomy – being HPV-positive is not good, as one would maybe think, due that POSITIVE implies 'something good'. This example is however not ideal since these expressions probably are common knowledge. Nevertheless, it does demonstrate the principle and the probability of there being such dichotomy fallacies in the scientific language.

Another example that illustrates the problem of pseudoscience is antithesis 21. Recall that it is discussed whether a complex was OPEN or CLOSED, and that such a state of a complex does not necessarily have to be dichotomous (but is in this case). However, just like POSITIVE/NEGATIVE, this antithetical pair seems gradable (hence a contrary opposition) and might therefore lead to misinterpretations regarding this complex discussed in the excerpt.

Perhaps, such fallacies may be encountered when the antithesis is not only contradictory but contrary as well – where a "cut" has been made from "a scale" or vice versa. An antithesis is sometimes contrary since the biological phenomenon discussed is gradable in some sense or cannot be interpreted as 'either this' or 'either that' – as would HPV-POSITIVE/HPV-NEGATIVE or OPEN/CLOSED, for example. But since the contrary opposition is combined with a

[153] cf. pages 6, 8-9

contradictory one, as in antithesis 25 (FOLDING/UNFOLDING), the receiver could interpret the antithesis as merely contradictory which hence creates a fallacy. Furthermore, the antithesis HPV-POSITIVE/HPV-NEGATIVE is a good example for demonstrating the case the other way around. This antithesis is a contradictory one, but contrary as well due to the gradability of POSITIVE/NEGATIVE. The problem is that you can only be either HPV-POSITIVE or HPV-NEGATIVE. You cannot be 'less or more' HPV-POSITIVE.

Something that was observed quite early in the analyzing process was that it is possible to interpret an opposition that could be categorized as contrary or dealt with a time frame, with *orientation* as one of the associated sensorimotor domains. When the antithesis comprises a contrary opposition it concerns a gradable entity that evokes the visualization of a linear scale or path, respectively, and hence involves a horizontal direction in an abstract space. Therefore, the contrary opposition belongs to *orientation*. Meanwhile, that being said, it does not mean that such an antithesis is more efficient for understanding. For instance, a contrary opposition that is categorized as *orientation* on the basis of bodily experience instead of the mere image of an abstract scale, probable enhances understanding to a greater extent due to stronger correlations to the own body. That does of course only apply if the body cannot be involved in the 'balancing' act of that abstract linear scale, as would perhaps be the case in Excerpt 7.

Intermediates seem not to be as efficient for understanding as do the others since they do not construct clear oppositions but instead allow for many different interpretations and oppositional alternatives, upon which the risk of misunderstanding increases. This was, for instance, encountered in Hoffmann (12) and in Yamanaka (3). However, intermediates can be constructive to understanding depending on context.[154]

Despite the quite useful categories of the opposites, they seem not entirely constructive since many antitheses can be categorized as more than one kind of opposition. But by means of categorizing, the different perspectives and genera of the antitheses can be identified, and hence it seems that the molecular biological information the antitheses provide is likely to be understood from different angles. Moreover, if antitheses can be defined they may be easier to relate to and understand. Consequently, a more efficient understanding is likely to take place since a better overall picture can be grasped. Perhaps, the categorization of spatial sensorimotor domains could be likely to contribute to a better understanding as well?

[154] cf. antithesis 12

5.1.3. Do spatial relations matter?

Although all sensorimotor domains were encountered, most antitheses were categorized as belonging to *motion* or *orientation* (see Appendix 2, Table 2). It seems that spatial conceptual antitheses could enhance and make understanding more efficient by means of comparing the (hypothetically) evoked visualized image with the own body and hence the memory of bodily experience together with antithesis (where the antithesis seems like an enhancer to the spatial expression) – assuming that Lakoff and Johnson's theory is corroborated. When antitheses belong to a sensorimotor domain they can perhaps be viewed more easily since they appear to behave in the same way as a human body, which may help understanding. The human body can move UP and DOWN in different ways. It can move IN and OUT or IN RELATION TO something else. The movement can be of various kinds, as was encountered in the analysis. Regardless, it is a movement that the body could realize since it has experienced it before, or because we can imagine that our body has done so. If recognizing the spatial conceptual antitheses, the interpretation and comprehension of abstract information, might become more efficient and easier to grasp. This due that the memory of bodily experience is used which is something that probably could related to by the receiver (as discussed in relation to Excerpt 9). Thereby, the information might seem less abstract, and thus easier to understand.[155]

Both the cognitive processes – memorization and comparison – seem to be involved when using and interpreting spatial conceptual antithesis. Not least when it comes to active processing, which appears a possible process that takes place in the comparison between the visualized image and the bodily experience, since what the process of comparison requires is what active processing deals with, i.e. grasping information by digesting it, thinking about it, reflecting on it, as well as using memory.[156] When comparing, the receiver is likely to digest the input, and think about and reflect on both what is being read as well as on the memory of bodily experience. By means of these processes, one might be more able to make sense of the new experience. Although it appears likely that active processing takes place, it cannot be corroborated in this thesis. In the course of the study, it became clear that it is possible for an antithesis to involve more than one sensorimotor domain (cf. Excerpt 17), and at times, even all three domains seemed inherent in the antithesis (as in Excerpt 3). From this case study, it is difficult to say whether multiple sensorimotor domains, working together, may enhance understanding even more than an antithesis where only one domain is dominant. However, it seems likely that an antithesis, involving more than one domain, has the power of enhancing

[155] cf. Excerpt 9
[156] cf. pages 11-12

understanding even more (which might also be the case when both might be interpreted as spatial although only one of them is spatial (as in Excerpt 6 or 11 in Südhof), due to close relation). When more than one spatial category is entailed by the antithesis, the bodily experience might be enhanced since one can compare bodily movement, not only to some kind of direction, but also *how* the body moves. Hence, a person can compare the antithesis and bodily experience on a greater number of premises, which might result in making the complex information less abstract and easier to relate to.

Meanwhile, the spatiality of the antithetical concepts might not matter more than does the antithesis itself. It is difficult to say whether it may be the clarifying character of the antithesis that makes the information easier to grasp or whether it is the spatial concepts. Moreover, although it is a possibility, the comparison between the body and the antithetical elements of the concept might not even take place. If Lakoff and Johnson's theory does not take place as a cognitive process or is important to understanding, then neither does the spatial conceptual antitheses. If these processes take place, then it is not clear whether they contribute to a more efficient understanding. Additionally and lastly, even though information which can easily be related to the own body seems easier to understand, this thesis cannot make claims on this matter. The antithesis, however, remains.

5.1.4. Conclusions: What seems more efficient for understanding?

From the reasoning in this section so far, together with the analysis and the theoretical perspectives and approaches used in this thesis, a few conclusions can be drawn:

- An active antithesis seems to be most appropriate for making understanding of complex information more efficient. This due the clarifying character of antithesis: 1) by presenting both opposites of the pair the receiver does probably not have to guess what is not being said; 2) when both opposites are explicit more information seems to be presented which hence completes the overall picture of a molecular mechanism. If grasping a more completed overall picture then understanding the mechanism seem more probable; 3) an active antithesis might call for active processing since a comparison is likely to take place between the first and the second encountered antithetical element. This could call for memory as well, and it may force the receiver to reflect on what was recently read. Thus, the information provided in the text seems more evident and is therefore better 'digested', upon which it might become more easily understood.
- The own body may be important for understanding. Since we probably are strongly connected to our body and know it by nature – such as its spatial experiences – any information that can be related to it accordingly could be understood more efficiently. Due to this comparison, the complex information might be easier to relate to, imagine and hence understand. The more sensorimotor domains inherent in the antithesis, the more parallels can be drawn between the text and the own body, which might make the information even easier to understand. The antithetical characters of the concepts seems to make the

bodily experience even more evident due to the reasons above – therefore it is difficult to say whether it could be the antithetical spatial concepts or the antithesis itself as an inventive rhetorical tool that makes the information more clear.

- A contradictory opposition seems to make the information easier to grasp due to an even more clear distinction, compared to any antithetical device. Secondly, such an opposition may also have the potential of enhancing the active character of the antithesis.

There might be a correlation between antithesis and understanding by means of bodily experience, i.e. spatial conceptual antithesis, and active processing – which both involves memory and comparison, on a lexical and perhaps on an embodied level. Another, and maybe stronger, correlation might be based on the antithesis' clarifying character. In summary, an antithesis that is most likely to result in a more efficient understanding probably entails a contradictory opposition (without creating a dichotomy fallacy) or a contrary opposition and is active. Although the study shows trends on that spatial conceptual antithesis enhance understanding (mostly when more than one sensorimotor domain is present), due to what seems to be a close relation to the body, it has to be further research.

5.2. Reflections on previous research, theory and present study

The following, final section will discuss the correlation between the results of this study and previous research. It will discuss the theories used, and how this study agrees and disagrees with it. Finally, a critical view on the present study will be presented, and to conclude this thesis, possible implications and further research will be discussed.

5.2.1. Embracing and challenging contemporary rhetoric

As mentioned in the introduction, today's rhetorical didactics are somehow based on what was teached in the classical times regarding rhetoric. The difference today however, is that the theories have become modernized. I have studied antithesis and put it in a modern perspective and begun to explore whether it may influence and perhaps also enhance understanding of complex information. Hence, I have tried to broaden the field.

The results of this study seem to somewhat agree with what Bain claims about antithesis; that human understanding is partly grounded on this chief mental operation.[157] One cannot be sure of course if this is the case, and definitely not based on the results from a theoretical case study, but the present study indicates that the antithesis may have the potential of enhancing understanding since it seems to make the information clearer for the receiver, and that in turn seems beneficial when trying to understand new, complex information – and

[157] cf. pages 3f

if not on a spatial conceptual antithetical basis, then at least on antithesis itself.

The study also agrees with Fahnestock's research and theory on explicit antithesis (what is called 'active antithesis' in this study), that antithesis is both a trope and a figure since it transforms the content whilst giving it a nuanced meaning by giving the content another, clarifying dimension – it seems that the antithesis is indeed easier to realize and grasp if it has a parallel structure. Why is still an open question: It could be due to strong discrimination which the mind comprehends more easily. However, as Fahnestock too points out, an inactive antithesis can meet the clarity that the active antithesis provides, *if* the NOT A of the antithetical pair is convention in the context, including "local" antitheses. Nevertheless, ultimately, the active appears preferable in most cases.[158]

Regarding Harris' suggestion, on the replacement of antithesis as a master trope instead of irony, this study agrees. Antithesis is not merely a figure that transforms the content it presents but it also gives it a nuanced meaning. Antithesis does so, not by including another domain as the metaphor does for instance, but by including another complementing dimension to the content within the same genus (what is NOT A) that would otherwise be excluded, antithesis adds another perspective to the content (if the antithesis does not constitute a confusing intermediate of course).[159]

However, a mere substitution of irony and antithesis is not enough. Since antithesis, metaphor, metonymy and synecdoche all comprise a comparison; the comparative element of these master tropes should be emphasized. It is also the comparative element between the oppositions as well as the comparative elements arising from using antithesis that calls for memory and makes active processing and bodily experience important and constructive. On the other hand, synecdoche is many times regarded as being a metonymy, hence there should maybe only be three master tropes. Then what trope should take the fourth place?

When turning to Lakoff and Johnson's theory, it may never be corroborated. However, testing whether spatial conceptual antitheses could aid understanding of complex information might be possible if the empirical data consists of students being exposed to this rhetorical device. As mentioned several times before, it cannot be assumed that bodily experience, evoked from the antithetical conceptual expressions, but the results show trends which are interesting to study further. There are possibilities to view expressions as spatial conceptual antitheses, which could be related to the body and hence could be more easily understood. The spatial metaphorical concepts could be constructive to the mind, and the clarifying

[158] cf. pages 10-11+14
[159] cf. pages 5-6, 10

character of an active antithesis, could intensify that constructiveness. Hence, the conceptual metaphors seem dependent on their antithetical character. On the other hand, the conceptual antitheses would not be constructive without their metaphorical character. They need each other.

5.2.2. Reasons to doubt antithesis

As in most studies, when analyzing empirical data, 'overanalyzing' is a problem. I admit that some antitheses might not be as evident to all, not least the antitheses that are strongly related to molecular biological information, i.e. "local antitheses". However, as stated elsewhere, antithesis is interpreted by consensus where pre-knowledge play an important role. [160] Therefore, the elicited antitheses in the excerpts might not be evident to all, but are to me (owing to my educational background). Yet, as long as I explain why some word pairs (if active) can be interpreted as an antithesis, and hence make them intersubjectively understood, they can still be interpreted as antitheses. I believe I have done so.

Another critique to this thesis is probably that many of the antitheses can be interpreted as metaphors, which I do not disagree with. Furthermore, that is of course expected since the conceptual metaphor theory is a big part of the analysis, in spite being implicit. Meanwhile, as was stated in the beginning of the thesis, I partly wanted to explore the antithetical perspective of spatial conceptual metaphors. Metaphors have been studied to a great extent, as have conceptual metaphors – so what new insights would the results of the analysis bring, if the word pairs would have been interpreted as metaphors?

Is antithesis enhancing understanding? If only A was to be present in a context, and if there was a NOT A that actually adds a dimension to the information the context provides, then indeed, by adding NOT A (which then would form the antithesis, assuming A/NOT A also meet the antithetical structure) to the context could enhance understanding. Because what is NOT A? Sometimes, it seems evident, as in the case UP or HAPPY or, to a molecular biologist, LIGAND, since *ordo naturalis* allows us to complement the words with its NOT A.[161] Meanwhile, perhaps only the opposite of UP would be evident, since HAPPY belongs to a genus which allows its opposite to be both SAD, DEPRESSED and maybe ANGRY. To a non-molecular biologist, LIGAND does probably not have any evident opposite. Thus, NOT A is not always evident, which is why the content becomes clearer when given its belonging NOT A. Sometimes, NOT A could also be confusing and sometimes it's irrelevant to include which is

[160] cf. page 13
[161] cf. pages 1, 8ff

why antithesis may not contribute to a better understanding. In addition, antithesis may create a better overall picture of whatever it presents, but is that overall picture influencing or enhancing understanding? Yes and no.

Is *spatial conceptual* antithesis enhancing understanding? According to this case study, antithesis might indeed enhance understanding by means of bodily experience and active processing on the basis of comparison and memory[162] – however only if the bodily experience becomes enhanced when using antithesis and if bodily experience – evoked by the information given – has a positive effect on understanding. Spatial expressions, which include molecular biological information, can indeed be found in the empirical data, but as stated below, perhaps only the receiver who knows what to looks for can gain anything from the spatial conceptual antitheses, hidden in the common expressions and conventional 'facts' within molecular biology (e.g. *ordo naturalis*). The study is however theoretical and must be put to practice in order to study if antithesis enhance understanding.

5.2.3. Possible implications on science education

Rhetoric helps changing the way we understand language and how language makes us understand things in a certain way. As pointed out in the introduction, from one point of view, rhetoric is but a set of meta-reflexive language tools that could help us reflect on our communicative choices. When approaching the rhetorical figures, focusing on what they do instead of what they are, their plasticity is recognized. Furthermore, one recognizes how they can be used as rhetorical tools in order to explore what we do with them and what they do to our minds. More important, once we realize how they seem to be incorporated in language and what influences they might have – such as perhaps being able to enhance understanding of complex information to natural science students – we have the potential of changing the way they are being used in order to get new, and maybe, more creative and constructive consequences.[163] Thus, it seems important to mention that even though active, spatial conceptual antitheses might make understanding more efficient, someone who has the ability of realizing the antitheses would probably acquire the most efficient understanding. If the receiver knows what an active, spatial conceptual antithesis is and what it perhaps can do to mind[164], the receiver is more likely to make her ways of thinking visible, and hence meta-reflect while eliciting these antitheses and reflect on how they relate to the own body. By means of meta-reflection, self-regulation may be improved, since the receiver (or sender)

[162] cf. pages 10, 16-18
[163] As the whisky distiller Sir Thomas Dewar once said: "Minds are like a parachutes. They only function when open".
[164] That it may evoke visualizations which can be compared to bodily experience, and that it calls for memory by means of active processing..

gains more awareness of the way she thinks, which results in more power of changing her way of thinking. When one is able to reflect meta-cognitively accordingly, self-regulation might become improved due to when the ways of thinking are visible, they can be changed more easily, and hence maybe the way of communicating as well.

A possible implication and a way of understanding more efficiently would be to introduce and test a meta-language, suitable for those who study molecular biology and other complex information. Evidently, such a meta-language should include antithesis. Recall that language is only a straitjacket if we allow it to be. More research on antithesis is needed to explore what more it might be able to do, and what it already does to us. Such research could for instance entail introducing and employing antithesis as a meta-term among students who study natural science, not least molecular biology. Thus one would perhaps be able to see if the students can let go of their straitjacket and view the scientific language from a new perspective in order to make their own understanding more efficient.

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