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The brain is like a muscle – the brain is like a control center: Conceptualizing the brain in expert and popularized scientific discourses

Georg Marko and Ute Wimmer
University of Graz, Department of English Studies

ABSTRACT This chapter examines conceptualizations of the brain as constructed in the discourses of popular science and the neurosciences, focusing on the dichotomy between *mentalism* and *physicalism*. This dichotomy rests on further conceptual oppositions, namely *holism* vs. *fragmentation* (brain or brain components), *personalization* vs. *de-personalization* (related to or abstracted from persons), and *agentization* vs. *passivization* (active or passive and not central in processes). The chapter takes a corpus-based discourse analytical approach, using corpora of popular scientific books on the brain and academic neuroscientific articles. As a triangulating effort, we add a questionnaire-based investigation into students' understanding of differences in linguistic representations of the brain. We examine various linguistic structures assumed to contribute to the conceptualizations mentioned. Quantitative results for these constructions are in line with our assumption that mentalism is more strongly associated with the expert-to-lay discourse of popular science and physicalism more with the expert-to-expert discourse of the neurosciences. Responses to the questionnaire indicate that mentalist and physicalist concepts play a role in students' understanding of the brain, but not in a clear and consistent way, possibly as a result of representations of the

brain students are exposed to which go beyond the discourses examined in our research.

KEYWORDS corpus analysis, discourse analysis, mentalism, physicalism

1 INTRODUCTION

To understand how the brain as a physical organ translates patterns of electrochemical activation into experience, thought and emotion, and thus physicality into mind, meaning and information is the ultimate goal of the interdisciplinary field of the cognitive neurosciences. It is widely acknowledged that Annemarie Peltzer-Karpf has contributed her substantial share to this endeavor, especially if the focus is on language and its ontogenetic development (for a selection of her works, see Hohenberger in this volume). As a discourse analyst (GM) and a sociolinguist focusing on lesser used languages (UW), we have no immediate contribution to make to the scientific study of the aforementioned connection between brain, mind and language, lacking the required expertise in anything cognitive or *neuro*. What we can do, however, is take the discourse analytical meta-position and investigate how the cognitive neurosciences conceptualize the brain in the ways in which the discipline uses language and creates meanings in discourse. This could mean looking at similes such as the two in the title of this contribution, but it could – and will, in our case – go well beyond such figurative representations.

Our perspective on cognitive neuroscientific language is informed by two dichotomies. Firstly, we will not only be concerned with academic texts and thus with how the brain is conceptualized within the exclusive expert community, but also with texts written by experts for a lay audience and thus with notions of the brain that might be more influential for the ways we as a society think about our most human of organs. If differences can indeed be found, then we expect them to be localizable on a scale from *mentalism* (focus on the mind) to *physicalism* (focus on the organic brain) – and this is the second of the aforementioned dichotomies. Our study will thus focus on aspects of meaning related to this

scale and the linguistic elements and structures that can be argued to help construct such meanings.

We will use corpus-based discourse analysis as our methodological approach, using a corpus of neuroscientific articles and a corpus of popular scientific books on the brain. In an attempt to triangulate the results of the text-based analysis, we will add a small-scale questionnaire-based investigation of how students perceive the different linguistic strategies and meanings found.

A caveat: our contribution will not focus on metaphors and metonymies of the brain, since the texts examined do not use them as widely as we would have expected (but see our comment on *brain* compounds in section 3). We nevertheless decided to retain the original title, as figurative language still captures better than other dimensions the variation in conceptualizing even something as physical as the brain.

2 PHYSICALISM AND MENTALISM

Physicalism means conceptualizing the brain primarily as a physical biological organ and modeling and explaining cognition mainly as physiological processes involving the various systems – nerves, blood, hormones, etc. – and structures of the physical brain. Mentalism, on the other hand, means conceptualizing the brain primarily as an information-processing system and modeling and explaining cognition mainly as mental processes involving an abstract architecture, all this always in relation to the *mindful* people in their personal and social environments.

The main objective of a popular neuroscientific discourse[1] is to create interest and establish comprehension in the non-expert target audience by using relatability – focusing on what the brain means to them as thinking, feeling, and perceiving and thus *mindful* individuals – and simplicity – focusing on an easily imaginable mental rather than a complex organic architecture. Experts talking to experts can presuppose knowledge and

1 We take a constructionist position here, assuming that discourses are particular forms of using linguistic forms and linguistic meanings associated with particular forms of conceptualizing the world.

do not need to take the aspects mentioned into account, which means brains can be abstracted from people and dissected into their organic, chemical and physical components. The different conceptual perspectives on the brain are thus contextually motivated, for instance by theoretical and practical goals, assumed shared background knowledge, etc.

Our main research question is whether and if so, to what extent a popularized discourse of the brain can be located more towards the mentalist pole of the scale mentioned above, and an expert discourse of the brain more towards the physicalist pole (that this is indeed the case is the guiding assumption – or our superordinate hypothesis, as it were – in our study), and where (i.e., with respect to which sub-aspects) and by which linguistic means such a difference becomes manifest.[2]

We assume that the distinction between mentalism and physicalism rests, among others, on the following three subordinate conceptualizations, which are at the basis of our sub-hypotheses and sub-research questions.

Holism vs. fragmentation: We associate mentalism with holism, this is, conceptualizing the world in terms of whole entities, particularly in terms of whole persons, whole bodies and – even though this is to a certain extent a contradiction in terms – whole organs. By contrast, we associate physicalism with fragmentation, this is, conceptualizing the world in terms of parts, with a particular emphasis on lower-order and *transsubstantial* (i.e., components are of a different nature than the whole) components.

Personalization vs. de-personalization: We associate mentalism with personalization, this is, conceptualizing the brain in relation to individual human people and their lives. By contrast, we associate physicalism with de-personalization, this is, conceptualizing the brain as abstracted and independent from its *owner*.

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2 This is our personal perspective on the issue. Others assume that the physical brain – especially represented by the visual image of this organ – has become the most prominent factor in popular science in many different fields. They mention examples such as personal identity, social behaviour or cultural phenomena that popular science now tends to locate in the physical brain (see Racine, Bar-Ilan & Illes, 2005; Thornton, 2011).

Agentization vs. passivization: We associate mentalism with agentization, this is, conceptualizing the brain as engaged in active and partly even intentional behavior. By contrast, we associate physicalism with passivization, this is, conceptualizing the brain as passively undergoing processes or as partly only playing an even more circumstantial role in processes, for instance being the place rather than an immediate participant.

Our task for the linguistic analysis is to look at linguistic elements and structures that create meanings contributing to these conceptualizations. This chapter does not stand in the tradition of studies on science popularization that look at how expert knowledge is represented in discourses targeted at a lay audience and at the transformation processes this involves, such as the foregrounding of science as a spectacle and scientists as geniuses and of the use value of scientific findings and the backgrounding of doubts or qualifications of results (for an early representative of the approach see Fahnestock, 1986). The focus will thus not be on this direct relationship between the two discourses under scrutiny.

3 APPROACH AND DATA

We use corpus-based discourse analysis as our approach, tracing patterns of meaning in recurrent configurations of linguistic elements and structures in collections of electronically-stored texts (= corpora), trying to relate the former to their social, cultural, political or other contexts (as outlined in Marko, 2015, drawing upon ideas presented in Baker, 2006; Fairclough, 1992; Mautner, 2009; Partington, Duguid, & Taylor, 2013). Concordance software allows us to find linguistic patterns in corpora, as it can search texts for particular elements or structures and display them in – and allows analysis of – their immediate verbal contexts (we used Wordsmith Tool 7.0 created by Mike Scott as our concordancing program). We compiled two corpora representing the two discourses described above: on the one hand professional texts on the brain written by experts for other experts in the cognitive neurosciences, and on the other hand popularized scientific texts on the same topic written by experts for a wider, non-expert readership.

Our professional corpus consists of academic articles from two important peer-reviewed academic journals, namely *Neuroscience*, with a stronger neuroscientific focus, and *Trends in Cognitive Sciences*, with a stronger general psychological focus. Considering that there are a wide range of high-profile journals in the field, any choice of two specific journals is always somewhat arbitrary. In this case, our choice was also practically motivated as we were looking for journals held by our university library in electronic format and which we could easily access and transform into text files. We included 100 articles in our corpus, 50 from each of the two publications, aiming for 500,000 words, a reasonable target for a research project like ours. We randomly selected one article from each of the 50 most recent issues of both journals (taking the first article from the first issue used, the second from the second, etc.; in case there were not enough articles in an issue, we started with the first one again).

Our popular corpus consists of popular science books on cognitive science and brain research. We would have preferred articles to avoid a generic imbalance, but popular scientific articles on the brain are published less regularly and less consistently in particular media so it is more difficult to find a sufficient number. To find relevant books, we used *brain* as a search word in the "popular science" category on amazon.co.uk and chose the first ten books listed that seemed to represent the target field from a fairly general perspective with a relatively recent publication date. Ten seemed a plausible number, containing some variation without resulting in a much larger corpus than the professional one. We bought the electronic versions of these books and transformed the texts from these into plain text files using OCR software (converting pictures – or scans – of texts into electronically readable text), excluding anything not part of the main running text (e.g., tables of contents, references, captions).

The two corpora were tagged for parts of speech/word classes and semantic categories with the help of the automatic tagger CLAWS, a service available via the platform WMatrix3 created and maintained by Paul Rayson (see Rayson, 2009). Table 1 includes all the relevant statistical information on the two corpora.

Table 1: *Descriptive statistics of the two corpora*

	Popular	Professional
Texts	10 books	100 articles
Overall size[3]	916,012 words	549,945 words
Range	45,337–126,705 words	2,356–12,883 words
Average length	91,601 words	5,499 words

The following four sections will focus on one of the three conceptual strategies described above and test assumptions about these against the data from the corpora just described.

4 RESULTS AND DISCUSSION

4.1 Holism vs. fragmentation

> Everything you are is a feature of *your brain*, and as such much of what *your brain* does is dedicated to making you look and feel as good as possible [...].

> *Neogenin-expressing neurons* in the *rhombencephalon* and *mesencephalon* projected to the *spinal cord*.

The first example above, with its references to the brain as a whole and to activities that the latter engages in, contributes to creating meanings that support a holistic conceptualization of the brain. The striking aspect of the second example is that it does not use the noun *brain* at all, but instead in one relatively short sentence features four complex and technical terms for brain parts and thus constructs a fragmented conception of the brain. In this section, we will look at linguistic elements such as those highlighted in italics in the examples above to see whether popularized neuroscience presents a more holistic view and professional neuroscience a more fragmented view of the brain, as hypothesized.

3 Not including the passages just mentioned.

The most obvious strategy of creating holistic meanings in connection with the brain is to use the very noun itself. We therefore looked for occurrences of the word *brain* in our two corpora. While the simple noun can certainly be argued to have the strongest effect with respect to holism, we decided to include all occurrences, whether in orthographically separate (e.g., *rat brain*), hyphenated (e.g., *Albert-Einstein-brain*), or orthographically combined (e.g., *forebrain*) compounds, whether in compounds with *brain* as the head (e.g., *bird brain*) or as the modifier (e.g., *brain disorder*), and whether as complex compounds (e.g., *blood brain barrier penetration*) or as derivations (e.g., *no-brainer*, *brainy*).

Table 2 below contains the absolute and relative frequencies (occurrences per 10,000 words, here and elsewhere) of *brain* occurring in any of the constructions mentioned in the previous paragraph. As the data covers a very heterogeneous set of constructions, we will not count the number of different expressions here, ignoring the aspect of lexical diversity.

Our approach to quantification relies heavily on descriptive statistics. However, we also compared all frequencies with the help of Log-likelihood [using an Excel spread sheet provided by Jiajin Xu (n.d.)]. All results to be presented in this article are statistically significant at $p < .001$.

Table 2: *Frequencies of the word brain occurring in any construction in the two corpora*

	Popular		Professional	
	Absolute	per 10,000 words	Absolute	per 10,000 words
Tokens	9,164	100.04	1,818	33.06

The word *brain*, on its own and in all the combinations described above, occurs almost exactly three times more often in the popular science books than in the neuroscience articles. As assumed, the brain as a whole entity – and thus holism – therefore plays a more significant role in the expert-to-public discourse than in the expert-to-expert discourse.

The examples of combinations involving the noun *brain* highlight the fact that there are many complex words integrating the brain as a whole organ. We would argue that such words, particularly compounds, also contribute to a holistic conception of the brain. This might seem par-

adoxical at first – after all, the brain is by definition incorporated into a larger or more complex concept in compounds, for instance in *brain training*, the brain only plays the role of the object of an activity. But as this more complex concept still features an explicit reference to the whole brain, rather than to its parts, attributes, or functions, the compounds denoting these concepts may eventually still enhance the holistic dimension of the texts in which they are included. We therefore decided to look at the frequencies and the lexical diversity of such compounds.

Table 3 includes the numbers of different nominal compounds with *brain* and their frequencies in our two corpora. Type numbers (how many different words, as opposed to token numbers, which represent how often words occur in a corpus), here and elsewhere in the article, are based on *lemmatization*, which means that different grammatical forms are all subsumed under one entry. Since there is no linear relation between type numbers and overall corpus size, relative frequencies are not provided.

We add a second relative number to tokens, representing the ratio between how often the word *brain* occurs in any construction in a corpus (the figures presented above) and how often it occurs in the above-described compounds (called *brain*-ratio in the following). It seems relevant since the frequency of a construction involving the word *brain* necessarily depends on the latter's overall frequency, too, not just on the size of the corpus. The value *x* can be read as 'one in x occurrences of *brain* is a compound [or any other construction]'. The full set of compounds found are contained in Supplementary Table A (see References).

Table 3: *Frequencies and lexical diversity of compounds with brain in the two corpora*

	Popular			Professional		
	Absolute	per 10,000 words	*brain*-ratio	Absolute	per 10,000 words	*brain*-ratio
Types	474			222		
Tokens	2,968	32.40	3.1	1,257	22.86	1.4

The figures in Table 3 present a heterogeneous picture. The popular science corpus contains a lexically much richer set of expressions, with more than twice as many different compounds. And, relatively speaking, *brain* compounds also occur approximately 50% more often in the pop-

ular neuroscience corpus. All these figures are in line with our expectations. However, if we factor in the number of occurrences of *brain* overall in the two corpora, which is what the *brain*-ratio does, we see a reversal of relations: ratios of 1.4 for the professional corpus and 3.1 for the popular corpus mean that if the neuroscientific articles use the word *brain*, even though they do so less frequently, it is more than twice as likely to be part of a compound. So the data on compounds does not provide support for the assumption that a holistic conception of the brain is a more central feature of a popular scientific discourse on the brain than of a professional one. It cannot easily be interpreted as counterevidence either. We rather assume that we underestimated other factors playing a role here, for instance, the fact that there is a tendency towards condensation in scientific discourses – presenting more information in smaller units – which normally leads to a more extensive use of compounds than in discourses targeting a more general audience.

A brief aside: when looking at the set of compounds we have found in our corpora, there are some that clearly have a metaphorical basis; we may even identify conceptual metaphors such as the brain is a building/architectural construct (realized in components such as *architecture*, *cell*, *wall*, or *bridge*) or the brain is a plant (realized in components such as *stem*, *branch*, or *growth*). In light of such findings,[4] we have to admit at this point that we might have given up too early on actually focusing on figurative language.

Let us look more closely at elements that enhance the opposing conceptualization, namely fragmentation. Lexemes denoting different parts of the brain are of prime importance here. We focus on two types of brain components, both of which qualify as *transsubstantial* (i.e., with an essential difference between these elements and the brain as a whole). These two categories are *neurotransmitters* (the substances chemically transferring electrical activation between nerve cells) and *neurocytology* (all aspects concerned with types and components of nerve cells).

4 We thank the anonymous reviewer who has drawn our attention to these expressions.

An exhaustive search in a corpus for terms[5] for neurotransmitters and neurocytology is impossible as the target structures do not share any formal features. However, there are sources, whether websites or books, that contain a wide range of relevant terms for the respective field. If search lists containing these words can be compiled from such sources, then approximative searches, covering the vast majority of – though not all – expressions, can be performed. We used such approximative searches for tracking the above-mentioned terms. Table 4 presents all the relevant figures concerning terms for neurotransmitters (for the full list of terms see Supplementary Table B).

Table 4: *Lexical diversity and frequencies of terms for neurotransmitters in the two corpora*

	Popular		Professional	
	Absolute	per 10,000 words	Absolute	per 10,000 words
Types	32		53	
Tokens	1,091	11.91	1,444	26.26

Unsurprisingly, and in line with our expectations, we see a clear quantitative advantage here for the neuroscientific articles over the popular scientific books with respect to both lexical diversity and frequency. Being more likely to refer to these small-scale and transsubstantial components, the professional discourse on the brain can therefore rightly be claimed to present a more fragmented conception of the brain than its popular counterpart. As far as neurocytological terms are concerned, figures for their lexical diversity and frequencies can be found in Table 5 (for a full list see Supplementary Table C).

5 We are using terms here in the sense of words that are "neutral and unambiguous, [...] condense information into compact units and their meanings are usually opaque being tightly integrated into a system of specialized knowledge that is created, administrated and disseminated in and by institutions (e.g., by medicine and professional healthcare)" (Marko, 2017, p. 150).

Table 5: *Frequencies and lexical diversity of neurocytological expressions (referring to entities) in the two corpora*

	Popular		Professional	
	Absolute	per 10,000 words	Absolute	per 10,000 words
Types	218		520	
Tokens	3,760	41.05	3,760	68.37

Our interpretation of the data on lexical diversity and frequencies of expressions for brain components on the level of the nerve cell reiterates the points made above in connection with neurotransmitter terms. There is a slight difference here, though, since the quantitative advantage for the professional neuroscience corpus primarily becomes manifest in the lexical diversity of neurocytology in the corpus, pointing to the detailed distinctions that are made there. The terms also occur more than 50% more often, relatively speaking, in the professional corpus than in the popular corpus, but the gap here is smaller than with neurotransmitters, mostly due to some high-frequency general terms that belong to this semantic class (e.g., *nerve* and *cell*). But all data suggests that the fragmentation of the brain plays a much more salient conceptual role in the expert discourse on neuroscience than in the popular discourse on the same topic.

If we consider all linguistic structures examined in this section, our overall conclusion is that our expectations have been fulfilled, with the exception of compounds with *brain*, where the results are somewhat heterogeneous, and that the expert-to-expert neuroscientific discourse creates a more fragmented conception of the brain and the expert-to-lay discourse a more holistic one. The former may therefore be said to be more physicalist and the latter more mentalist, if we accept the conceptual associations between fragmentation and physicalism, on the one hand, and holism and mentalism, on the other.

4.2 Personalization vs. de-personalization

> In a series of brilliant experiments *he* showed that the shape of [the maps of *our brains*] changes depending upon what *we* do over the course of our lives.

> Incorporating the statistical methods mentioned above is vital to harness the power of Network Science to reveal the dynamical principles by which *the brain* is structured and by which brain functions emerge, develop, and decay.

The first example above, with its references to persons in the immediate co-text of the word *brain* (or a compound containing it, to be more precise) and especially with its use of the possessive pronoun *our*, which stresses the link between person and organ, contributes to a personalized conception of the brain. By contrast, the second example avoids mentioning persons by using subject-less non-finite verb forms (*incorporating*, *to harness*, *to reveal*) and the agent-less passive voice (*is structured*) and by combining *brain* with the definite article *the* rather than with a possessive pronoun. The meanings created are much more abstract and distanced, contributing to a de-personalizing perspective on the brain. In this section, we will look at linguistic elements such as those highlighted in the examples to see whether popularized neuroscience presents a more personalized and professional neuroscience a more de-personalized view of the brain, as hypothesized.

Explicitly relating the brain to its *owner* by using a possessive pronoun (*our brains*) or a genitive (*the patient's brain*, *everyone's brain*) is the first linguistic structure we will examine in this section. As the majority of these *owners* are human beings, this construction creates a direct link between the organ and a person and can therefore be argued to create personalization. Table 6 below contains all the relevant figures describing the frequencies of this construction in the two corpora.

Table 6: *Frequencies of 'brain' occurring with a (personal) possessive (possessive pronoun or genitive noun) in the two corpora*

	Popular			Professional		
	Absolute	‰	*brain*-ratio	Absolute	‰	*brain*-ratio
Possessive + *brain*	1,563	17.06	5.9	21	0.38	86.6
Possessive + *brain* (human)	1,489	16.26	6.2	11	0.20	165.3
Possessive + *brain* (animal)	74	0.81	123.8	10	0.18	181.8

Note. ‰ = per 10,000 words.

As can be seen from Table 6, the two corpora differ substantially with respect to the use of possessives in connection with the brain. In the neuroscientific articles, the construction [possessive + *brain*] is generally very rare with only one occurrence per 25,000 words (approximately) and with only one instance per 87 occurrences of the word *brain*. The gap to the popular books is wide: in the latter the combination is used more than 40 times more often overall, and with one occurrence per six explicit references to *brain*, we can truly claim that relating the organ to its *owner* is a very common pattern in these texts. Considering that almost half of all possessive constructions with *brain* in the expert articles are concerned with animals, but only about 5% are in the popular books, the relevance of these numbers for the construction of personalization in the latter is further enhanced. We may therefore conclude that, in agreement with our prediction, the popular scientific discourse on the brain has a more prominent element of personalization than its expert counterpart.

The first of the introductory examples in this section suggests that talking about human beings at the same time as talking about the brain may also have a personalizing effect on our conceptions of the brain. We will therefore examine how common this phenomenon is in the two discourses under scrutiny. Linguistically speaking, we interpret this as the word *brain* occurring in close vicinity to expressions referring to human beings. Practically speaking, we thus looked for a reference to a person occurring in the same sentence within a span of five words to the noun *brain*. This does not specify the relationship between the person and the organ, there is just the assumption that mere co-occurrence creates a link between the two dimensions. In Table 7, we present the absolute and

relative frequencies of *brain* and references to human beings co-occurring in the two corpora.

Table 7: *Frequencies of 'brain' occurring together with a noun referring to a person (within a space of five words within the same sentence) in the two corpora*

	Popular			Professional		
	Absolute	‰	*brain*-ratio	Absolute	‰	*brain*-ratio
brain + personal reference	1,563	17.06	5.9	97	1.76	18.7

Note. ‰ = per 10,000 words.

With a relative frequency that is ten times as high and a *brain*-ratio that is only a third (keeping in mind that the *brain*-ratio is inversely correlated with frequency), there is also a considerable quantitative advantage for the popular science books over the neuroscientific articles. As the former are thus much more likely to talk about the brain in connection with human beings than the latter, our assumption that personalization is an important conceptual strategy in the expert-to-lay discourse on neuroscience, but less so in the expert-to-expert discourse, seems very plausible.

What could relativize the figures presented above is the fact that scientific discourses are generally more impersonal and abstract so that it is less a lack of a personalized conception of the brain, but rather a general absence of a personalized perspective on the world. While this seems indisputable, we would nevertheless maintain that it is still legitimate to look more specifically at the conceptualization of the brain in a scientific discourse and describe it independently, even though this conceptualizing blends in with the general perspective conveyed.

In conclusion, the linguistic elements and structures examined in this section provide support for our assumption that popular neuroscience presents a conception of the brain that is more tightly associated with and related to human beings, while professional neuroscience prefers a perspective on this organ that abstracts from persons. If we accept the idea put forward in section 2 that opposition between personalization and de-personalization is subsumable under that between mentalism and physicalism, all this lends further weight to the hypothesis that pop-

ular notions of the brain are more mentalist and professional ones more physicalist.

4.3 Agentization vs. passivization

> In the case of anger, something happens, your brain *experiences* it, *decides* that it*'s really not happy* about it, and produces an emotion (anger) in order to *respond* and effectively *deal with* it in a satisfactory manner.

> Although effects at the cellular level may be heterogeneous, all anesthetic agents are similar in decreasing neuronal firing, either through the enhancement of inhibitory currents or the reduction of excitatory currents *within the brain*.

In the first example above, the noun *brain* serves as the subject of several verbs, namely *experience*, *be happy*, *decide*, *produce*, *respond* and *deal with*. The subject of the latter four takes an active role; in the former two, it has the role of an entity – normally a human being – mentally experiencing something. These linguistic details contribute to the construction of the brain as an agent and as human being-like. By contrast, the second example generally represents processes in a very abstract way – mostly by using nominalizations such as *firing*, *enhancement* or *reduction* – and who or what is involved in or affected by these processes remains unclear. What is obvious, though, is that the brain is not more immediately, let alone actively, participating in these processes, but just provides the location for the latter as the noun *brain* just occurs inside a prepositional phrase headed by the locative preposition *within*. This section will be concerned with linguistic elements such as those highlighted in the examples as we are trying to investigate whether popularized neuroscience incorporates a more agentizing and professional neuroscience a more passivized conception of the brain, as hypothesized.

Both linguistic strategies featured in this section are concerned with the noun *brain* and the semantic roles it is assigned in clauses, and the amount of *agency* that inheres in these roles (for semantic roles, see Halliday, 1994). If we define agency as the extent to which someone or something is able to actively and independently initiate and carry out a

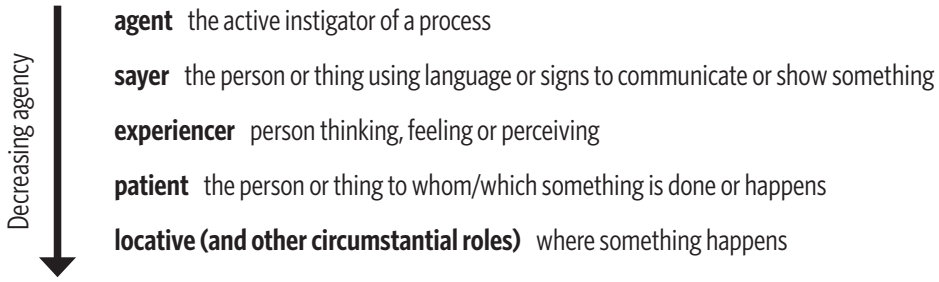

Figure 1. Scale of agency.

process, then the semantic roles mentioned above form a scale of agency, which could look as illustrated in Figure 1.

We need to distinguish between two different types of *experiencer* because especially processes of thinking and perceiving might be intentional, such as, thinking (about something), deciding, observing, listening, or unintentional, for instance, believing, remembering, seeing, hearing. Therefore, there are *active experiencers* and *passive experiencers*, the former of course coming before the latter on the above scale.

We were interested in how often the brain appears in the more active roles, this is, as agents, sayers and active experiencers, and how often in the passive circumstantial role of the locative.

Readers find information on frequencies and lexical diversity (of the verbs) in Tables 8 and 9. The latter presents how often *brain* occurs in the individual roles of agent, active experiencer and sayer. As a comparison, Table 8 also includes the relevant numbers for the passive experiencer category (for the list of all the verbs involved, see Supplementary Table D).

Table 8: *Lexical diversity and frequencies of 'brain' occurring in an active semantic role in the two corpora*

	Popular				Professional			
	Types	Tokens	‰	*brain*-r	Types	Tokens	‰	*brain*-r
brain in active semantic role	209	545	5.95	16.8	24	33	0.60	55.1

Note. ‰ = per 10,000 words; *brain*-r = *brain*-ratio.

Table 9: *Lexical diversity and frequencies of 'brain' occurring in the three different active semantic roles (plus the role of the passive experiencer) in the two corpora*

	Popular						Professional					
	Ty	%	To	%	‰	*brain*-r	Ty	%	To	%	‰	*brain*-r
Agent	153	73.2	384	70.5	4.19	23.9	16	66.7	22	66.7	0.40	82.6
Active exp.	37	17.7	129	23.7	1.41	71.0	6	25.0	8	24.2	0.15	227.3
Sayer	19	9.1	32	5.9	0.35	286.4	2	8.3	3	9.1	0.05	606.0
Totals	209		545				24		33			
Passive exp.	118		348		3.80	26.3	0		0			

Note. Ty = Types; To = Tokens; ‰ = per 10,000 words; *brain*-r = *brain*-ratio; exp. = experiencer.

As predicted, the noun *brain* occurs significantly more often in an active semantic role in the popular books on neuroscience than in the expert articles (ten times more often in relation to the overall corpus size, and three times more often if just related to the frequencies of the word *brain*). So overall, the data lends some credence to our assumption that in a popular discourse on the brain, agentizing plays an important role in the conceptualization of this organ.

There are no significant differences between the overall numbers and the numbers for the three different active semantic roles (agent, active experiencer, sayer). However, a closer look at the verbs actually used with *brain* in an active role, particularly those in the popular brain research corpus, points to another aspect indirectly related to mentalism. This aspect is perhaps most obvious in the active experiencer category. So what is our notion of a brain that attends to something, chooses, compares, concludes, controls, decides, ignores, infers, interprets, makes assumption, predicts, reassesses, searches for, and teaches itself? Particularly if we add the verbs in the passive experiencer category, where we also see a brain that assumes, believes, guesses, gets things mixed up, knows, prefers, remembers, thinks, and wants? It seems that the brain engages in the same mental operations – whether active or passive – that we, as whole human beings, also use. This means that on a certain level, there is an equation of the brain with the whole person, especially with the thinking, feeling and perceiving person. To put it differently, the

brain is almost a metonymic reference to a mindful human being rather than just being a part of it. This can clearly be seen as an additional factor supporting the overall hypothesis of the prominence of mentalism in a popular discourse on the brain. Keep in mind that this dimension is practically absent from the professional brain research corpus because the active experiencer category is so small in comparison, and no instances of *brain* occurring in the passive experience role have been found.

A circumstantial role, which describes the setting of an event rather than being immediately involved in it, means having no direct impact or influence on the initiation and performance of a process. Passivization is created by the brain often and consistently occurring in such roles, with special emphasis on the locative role, this is, any role concerning the *Where*, *Where from*, *Where to*, and *How far* of a process.

If *brain* takes a circumstantial role, it must occur inside a prepositional phrase. Our task in this part of our study is thus to look for such prepositional phrases. We searched for prepositions (with the help of the grammatical tags) if followed by *brain* within a span of three words. Three words would be enough to cover the majority of cases where words intervene between the preposition and *brain* without at the same time producing too many false positives.

Table 10 contains all the relevant figures concerning the occurrence of *brain* inside prepositional phrases in general, and locative prepositional phrases more specifically (for the list of prepositions, see Supplementary Table E). The percentage represents the proportion of locative prepositional phrases in the overall number of prepositional phrases with *brain*.

Table 10: *Frequencies of brain occurring inside preposition phrases with or without a locative meaning in the two corpora*

	Popular				Professional			
	Absolute	‰	%	*brain*-r	Absolute	‰	%	*brain*-r
brain in locative PP	1,019	11.12	42.3	9.0	242	4.40	58.7	7.5
brain in PP	2,410	26.31		3.8	412	7.49		4.4

Note. ‰ = per 10,000 words; *brain*-r = *brain*-ratio; PP = prepositional phrase.

The general figures in Table 10 are not really conclusive. While relatively speaking, such constructions with *brain* in a prepositional phrase are more common in the popular books on neuroscience, contrary to expectations, the *brain*-ratios are fairly similar. The fact that locative prepositions form a larger proportion of all prepositions used in the expert articles and that the *brain*-ratio for these prepositions is slightly lower (pointing to a higher likelihood of references to *brain* being part of corresponding prepositional phrases) does not really provide support for our expectation that an expert discourse on neuroscience contributes more to a passivization of the brain than a popular discourse on the same topic.

In conclusion, the data examined in this study lends weight to the one side of our assumption, suggesting that an expert-to-lay discourse on the brain contains a much stronger element of agentization than its expert-to-expert counterpart. However, the data fails to enhance the plausibility of the other side of the assumption as we could not find positive evidence that the professional discourse does in fact present the brain as very passive. We might infer this by implication – after all, if the brain is not active, it must be passive – but not based on the data reviewed. There is a wide range of verbs in the popular discourse which take *brain* as their subject and assign the experiencer role to it. This suggests that there is a blend of the brain with the thinking, feeling and perceiving whole human being, which supports the conclusion that there is not just a difference between the two discourses under analysis with respect to agentizing, but that the popular discourse on neuroscience generally conveys a more prominent mentalist conception of the brain than its professional counterpart.

5 TRIANGULATION: THE QUESTIONNAIRE

This section will briefly discuss the results of a questionnaire that we created to see whether the claims raised in connection with our textual analyses are also relevant if we take a closer look at recipients and their conceptions of the brain. As this part of the study is low-key and small-scale, this form of triangulation must be regarded as an expression of intent rather than the full implementation of a methodological principle.

The idea behind the questionnaire is to find out whether the distinction between mentalism and physicalism and the three sub-conceptualizations examined above are also salient components of people's interpretations of texts concerned with the brain. In addition, we are also interested in whether there is metalinguistic awareness of which linguistic aspects may be instrumental in affecting meanings and interpretations (see "Questionnaire" in References).

We chose the short passages introducing the three sections dedicated to the subcategorizations as our examples for the questionnaire because they highlight the conceptual oppositions we are interested in, even though this by itself may create a less than authentic scenario for an interpretation. For all three pairs, we asked questions about differences concerning impressions and interpretations and also linguistic elements that contribute to the former. We explicitly mentioned the aspects we thought were most relevant for each pair.

There are three further questions at the beginning of the questionnaire. These are supposed to fulfill two tasks. Firstly, they have a *priming* function, foregrounding – and thus making respondents aware of – differences in our thinking and our representations of the brain. This is achieved by using questions that involve ranking different conceptualizations of the brain, whether as a biological organ, a site of electrochemical activity, a whole person, a source of identity construction, etc. A further aspect contributing to this function is that the three questions focus on different forms of representation, the first one including (literal) definitions, the second one metaphorical representations (e.g., the brain is a computer or a city), and the third one pictures. Secondly, the three questions will also allow some insights into respondents' notions of the brain prior to and therefore independently from the main, language-based questions described above.

As we primarily wanted to *explore* the possibility of triangulation, we did not aim for systematicity, exhaustiveness, and/or representativeness. We therefore only had 5 respondents, all 18-year-old female students at a college for nursery education (BAfEP 'Bildungsanstalt für Elementarpädagogik') in Linz[6] who, as native speakers of German, had learned English as a foreign language for at least eight years. Students of that age

6 One of the authors (UW) is a teacher at this school.

group appeared to be an interesting cohort because we assumed they would not have more extensive experience with either neurological or popular psychological texts so that they would approach the textual examples with relatively few preconceptions. We added German translations as English was not the respondents' native language, which might have constituted a major obstacle. While having native speakers of English would definitely be preferable, we opted for *second best* in this case for pragmatic reasons, a legitimate decision considering the status of our investigation.

Responses to the first three questions – we here relied on an informal and simple form of content analysis – reveal that there is no clear prominent conception of the brain. This becomes obvious, for instance, in the fact that two people rank *The brain is a site with complex patterns of electrochemical activity happening all the time* as the best definition and two *The brain is central to who I am*, two sentences which appear conceptually unrelated and far apart.

What we may have underestimated is that certain options in the three first questions are more conventionally and directly associated with the brain even though this might not necessarily mean a stronger impact on overall conceptions. So respondents might choose the computer metaphor rather than descriptions relating the brain to a person simply because the former is an often-used and thus frequently-encountered figure of speech even though the second metaphor (brain as a whole person) may be a stronger factor in our view of the brain. This may also apply to pictures of the brain (as isolated from the person) or of neuronal networks, which could also be argued to be the culturally more salient representations of this organ than a group of people talking to each other, even though under different circumstances respondents may still give preference to the notion of the *social brain* over a fragmented biomedical one.

As far as the two passages related to the opposition between fragmentation and holism are concerned, respondents say that the first example presents the brain as a physical object – "what you 'see' inside the brain"[7] – and foregrounds its parts, sections and structures. The second example is less interpreted in terms of a holistic view of the brain, but rather as

7 All examples are SIC.

highlighting its role for humans and their experience – "how the brain is affecting the humans" – and would therefore put more emphasis on personalization. The main linguistic element mentioned as relevant for creating meanings in the examples given is technical – variously called *technical*, *academic*, *medical*, or *complicated* – language and, more specifically, technical terms.

The comments on the second set of examples are very similar. Again, one passage is perceived as personal and concrete, the other as more abstract. Technical language is also seen as important in creating this difference. The respondents all mention that using the possessive pronoun *our* rather than just the definite article *the* in connection with *brain* also contributes to creating personalization in the first example. Two answers also refer to the metaphor of the map as a personalizing factor: "The first passage is more personal than the other one, because the writer describes the brain as a map which is more imaginable for me."

Respondents have greater problems with the last pair of examples, as four of five focus more on differences in comprehensibility – the first one being easier and the second one more difficult to understand, again mostly as a result of technical language – but only superficially touch upon the issue of agency. The fifth respondent, however, gives a relatively clear statement on the difference, saying "Passage number one attributes a lot of power to the human brain. It's in position to make its own decisions, or probably for the whole person, it's able to weigh and to deal with the environment's influences. Statement two makes the brain look like a robot that reacts instinctive and arbitrary without having huge impact."

In conclusion, the results of the questionnaire indicate that the dichotomy of mentalism and physicalism and its sub-categories play a role in people's conceptions of the brain, particularly in the interpretations of concrete textual examples. However, we do not see any clear and consistent trends in how this might affect general notions.

We are aware that this part of our study plays an inferior role to the corpus analysis simply because the number of respondents and the fact that they were not native speakers do not allow any further-reaching conclusions. We are also aware that the selection of examples and the explicit mentioning of certain conceptualizations in our questions had an effect on responses. What we might have underestimated is the multiple and diverse influences that particularly students focusing on pedagogy

are exposed to in their studies with respect to views of the brain and also the impact that culturally salient conceptions and representations have. Of course, only a larger, more representative sample of respondents allows insight that could really support or challenge the findings of our textual analyses.

6 CONCLUSION

In order to pay tribute to Annemarie Peltzer-Karpf, who as a teacher has sparked our interest in linguistics and as a colleague inspired us to pursue this interest further, we changed the conjunction of her special field into a preposition, turning *language AND the brain* into *language ABOUT the brain*, a theme that we feel more comfortable with.

Language about the brain in our case meant a discourse analysis focusing on conceptualizations of the brain as constructed in popular scientific books and academic articles on the cognitive neurosciences. Our initial hypothesis was that the former would represent the brain mainly as a mental information-processing device standing in close relation to its *owner* (sometimes even being equated with them), a conceptualization we called *mentalism*, and the latter would represent it mainly as a physical and biological entity, a conceptualization we called *physicalism*. We further assumed that the opposition between mentalism and physicalism could be mapped onto further dichotomies, namely holism vs. fragmentation (conceptualizing the brain as a whole or in terms of its parts), personalization vs. de-personalization (conceptualizing the brain as related to and associated with persons or as personally de-contextualized and abstract), and agentization vs. passivization (conceptualizing the brain as active and initiative or as passive and not centrally involved in processes). These dichotomies also formed the backbones of our sub-hypotheses, which we tested against quantitative and qualitative data from our corpora.

In connection with holism, we examined the use of the word *brain* itself, generally and when integrated into nominal compounds, in connection with fragmentation and the use of terms for neurotransmitters and nerve cells. Our analysis of personalization focused on the frequen-

cies of the noun *brain* occurring with a possessive pronoun or a genitive or in any combination with a reference to a person. Finally, studying agentization meant looking at the use of *brain* in active semantic roles in clauses, while studying passivization meant looking at the use of *brain* inside prepositional phrases, particularly those with locative meanings.

Overall, most results our analyses yielded provide support for our hypotheses. Only the data on compounds and on prepositional phrases were not conclusive, without, however, substantially undermining our assumptions either. Our investigation into conceptualizations of the brain in two different discourses thus suggests that our superordinate hypothesis that notions of the brain as presented in popular scientific books on neurosciences and academic articles differ with respect to the dichotomy mentalism vs. physicalism seems plausible.

A questionnaire-based study of how students interpret relevant texts – designed to add a triangulating dimension to our research – indicates that mentalist and physicalist concepts do play a role in their understanding. However, given the small scale of the study and the inconsistencies of the results, no far-reaching conclusions can be drawn. What becomes evident from the answers given in the questionnaire is that conceptions of the brain are always subject to all kinds of other influences so that eventually how people think of and evaluate the central human organ may be a heterogeneous mixture of different aspects.

And right at the end, when we were about to step down from the main stage, someone came up to us and asked "But why would we want to know? I mean, about the brain and stuff." We remained silent for a moment. And then we said "Discourse analysis is a bit like a mirror, creating a reflection on and for those we examine. Now a science of the brain that overemphasizes the biological, chemical and physical dimensions of the organ (to what extent this is really what we have found is another matter) may wonder to what extent it also is a humanity, a discipline exploring what it means to be human. And a science of the brain – even if popularized – that overemphasizes the mental dimension of the organ may wonder whether it is too much of a humanity, not sufficiently distinguishing between the mind and its biological foundation." The woman looked at us for a few seconds, raising her eyebrows. Then she said, "Well, if you say so" and disappeared.

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