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Affective and esthetic processes in reading

A neurocognitive perspective

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Apollonia Bohrn (1900-1994)
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Abbreviations

LH	Left hemisphere
RH	Right hemisphere
fMRI	Functional magnetic-resonance imaging
fMRT	Funktionelle Magnet-Resonanz-Tomographie
PET	Positron emission tomography
EEG	Electroencephalography
IFG	Inferior frontal gyrus
IPL	Inferior parietal lobe
medFG	Medial frontal gyrus
STS	Superior temporal sulcus
STG	Superior temporal gyrus
MFG	Middle frontal gyrus
SFG	Superior frontal gyrus
ITG	Inferior temporal gyrus
MTG	Middle temporal gyrus
IOG	Inferior occipital gyrus

Zusammenfassung

Bei einer geschätzten weltweiten Alphabetisierungsrate von ≈ 80% zählen Lesen und Schreiben heutzutage zu den wichtigsten Kulturtechniken. Lesekompetenz wird in eine Reihe von Alltagssituationen verlangt, angefangen vom Lesen der Speisekarte in einem Restaurant, oder des Fahrplans an der Bushaltestelle, bis hin zu der Notwendigkeit hoch formelle Schriftstücke in bürokratischen Abläufen zu verstehen. Während solche Situationen vor allem verständnisorientiertes Lesen erfordern, gibt es quer durch alle Gesellschaften eine große Anzahl an Menschen, die zum puren Vergnügen lesen, bzw. weil sie durch das Lesen facettenreiche emotionale Erfahrungen machen können (Oatley, 1994). In den Geisteswissenschaften hat die wissenschaftliche Auseinandersetzung mit der Ästhetik der Sprache in Form von Poetik und Rhetorik eine Tradition bis zurück zu Aristoteles. Angesichts dessen ist es verwunderlich, dass die Psychologie zwar über elaborierte Modelle der visuellen Worterkennung (Coltheart et al., 2001; Grainger and Jacobs, 1996; McClelland and Rumelhart, 1981; Seidenberg and McClelland, 1989), des Satz- und Textverständnisses (Friederici, 2002; Graesser et al., 1994; Kintsch and Dijk, 1978), der Entwicklung von Schrift- und Lesekompetenz, sowie deren klinische Störungsbilder (Frith, 1985, 1986) verfügt, jedoch wenig bis gar nichts über affektive und ästhetische Prozesse beim Lesen zu berichten weiß. Seit dem Einzug neurowissenschaftlicher Methoden in die experimentelle Psychologie und durch ein wiedererwachtes Interesse an Emotionen in den letzten Jahren hat sich eine kritische Masse an Befunden angesammelt, die den Einfluss affektiver Variablen auf den Leseprozess belegen (Briesemeister et al., 2011a; Citron, 2012; Silva et al., 2012; Võ et al., 2009, 2006). Diese Befunde sind allerdings bisher noch kaum in die großen Lesetheorien eingeflossen.

Parallel dazu ist in den letzten Jahren das Interesse daran gestiegen, den Entstehungsprozess von ästhetischen Urteilen mithilfe experimenteller und neurowissenschaftlicher Methoden zu ergründen. Befunde aus experimenteller neurokognitiver Forschung liegen zurzeit vor allem für den Bereich der visuellen Kustwahrnehmung, der physischen Attraktivität sowie der Musik vor. Dass auch Text, z.B. in Form von Literatur oder Poetik ästhetisch betrachtet werden kann, wird höchstens am Rande erwähnt (Chatterjee, 2011; Nadal and Pearce, 2011). Das Modell des literarischen Lesens von Jacobs (2011) ist derzeit das einzige Modell, das Verhaltensdaten aus dem Bereich der empirischen Literaturwissenschaften mit einer literaturwissenschaftlich-philosophischen Perspektive und Expertise über die Arbeitsweise des menschlichen Gehirns vereint. Die meisten Annahmen dieses innovativen Modells wurden jedoch bisher noch nicht experimentell überprüft. Das Ziel dieser Dissertation war es deshalb, zunächst die zentrale Annahme des Modells des literarischen Lesens zu prüfen, die lautet, dass sich literarisches Lesen als Wechselspiel aus zwei komplementären Arten des

Lesens ergibt: (a) Als ein relativ automatischer Modus des "Hintergrund-Lesens" wird das Lesen von erwartbarem, wörtlichen Text verstanden, das sich vor allem in den fronto-temporalen Regionen der linken Gehirnhälfte abspielt. (b) Ein Modus des "Vordergrund-Lesens" wird angenommen, sobald Leser auf ein Wort oder eine Passage treffen, die schwierig zu verarbeiten und relativ unerwartet ist. Solchermaßen hervorgehoben (foregrounded) können z.B. Wörter sein, die nicht zu den angesammelten früheren Leseerfahrungen (dem Repertoire von Lesern) passen, generellem Weltwissen oder dem vom Leser an jeder Stelle aufgebauten Situationsmodell widersprechen (Kintsch and Dijk, 1978), oder allerdings durch stilistische Techniken, z.B. rhetorische Figuren betont werden. Es wird erwartet, dass sich Vordergrund-Lesen tendenziell Strukturen der rechten Gehirnhälfte bedient.

Um die Mechanismen des "Vordergrund-Lesens" näher zu untersuchen, habe ich im Rahmen dieses Dissertationsprojekts eine Meta-Analyse zur neuronalen Verarbeitung figurativer Sprache, ein fMRT-Experiment zur Verarbeitung semantischer Hervorhebungen und eine Serie an Ratings und Verhaltensexperimenten zu nicht-semantischen Formeffekten am Beispiel Reim und Metrum durchgeführt. Obwohl in der Rhetorik eine Vielzahl von rhetorischen Figuren und Stilmitteln unterschieden wird, konzentriert sich die psycholinguistische Forschung nahezu ausschließlich auf Stilmittel der figurative Sprache, und dabei im Speziellen auf Metaphern (Bohrn et al., 2012b). In der Meta-Analyse, die in Kapitel 2 vorgestellt wird, wurde deshalb untersucht, ob fMRT-Experimente, die sich mit dem Lesen figurativer und wörtlicher Sprache befassen, unterschiedliche Lesemodi nahelegen, wie im Modell des literarischen Lesens postuliert wird (Jacobs, 2011). Mithilfe einer quantitativen Meta-Analyse wurden unterscheidbare Netzwerke für das Lesen von figurativer und wörtlicher Sprache identifiziert. Allerdings ergaben sich keine Hinweise auf Unterschiede in der Lateralisierung der Netzwerke. Das Lesen von "vordergründiger" figurativer Sprache rekrutierte große Bereiche aus dem linken Temporallappen, den bilateralen inferior frontalen gyri (IFG), dem medialen Frontalkortex und der linken Amygdala.

In dem fMRT-Experiment, das in Kapitel 3 und 4 berichtet wird, wurde "Vordergrund" dadurch operationalisiert, dass der Grad an Vorhersagbarkeit eines Einzelwortes im Kontext eines bekannten Sprichworts variiert wurde (Bohrn et al., 2012b). Durch das Einfügen eines unerwarteten Wortes in ein bekanntes Sprichwort wurden die bilateralen IFG sowie die inferioren gyri occipitalis (IOG) aktiviert, was darauf schließen lässt, dass durch "foregrounding" die Aufmerksamkeit auf das unerwartete Wort gelenkt wird. Bei dem Vergleich von verschiedenen Arten des foregrounding zeigte sich, dass Hervorhebungen auf Satzebene (wenn durch das ausgetauschte Wort die gesamte Satzbedeutung verändert wurde) eher die Beteiligung von affektbezogenen Gehirnregionen wie dem medialen Prefrontalkortex auslösen, als Hervorhebungen auf Wortebene

(wenn trotz des ausgetauschten Worts die Satzbedeutung erhalten blieb). Dieses Ergebnis lässt vor allem den Schluss zu, dass es nicht einen homogenen Modus des Vordergrund-Lesens gibt, sondern dass durch unterschiedliche Hervorhebungstechniken auch zumindest teilweise unterschiedliche Netzwerke im Gehirn angesprochen werden.

Die Ergebnisse aus Meta-Analyse und Sprichwort-Experiment implizieren, dass ein Modus des Vordergrund-Lesens durch erhöhte Aufmerksamkeit sowie stärkere Beteiligung von Gehirnregionen der Semantik-Verarbeitung charakterisiert ist, und einsetzt, sobald ein Text schwerer zu lesen wird. Es gab jedoch entgegen der Hypothesen des Modells des literarischen Lesens keinen Hinweis auf eine grundsätzliche ästhetische Präferenz für Text, der durch Vordergrundelemente hervorgehoben ist. Eine parametrische Re-Analyse der Daten aus dem Sprichwort-Experiment zeigte allerdings, dass spontane ästhetische Evaluation auch beim leisen Lesen stattfindet, selbst wenn es keine explizite ästhetische Bewertungsaufgabe gibt.

Während die Versuchsteilnehmer im fMRT-Experiment klar die bekannten Originalsprichwörter gegenüber verfremdeten Versionen bevorzugten, demonstrieren die Rating-Ergebnisse aus dem Experiment aus Kapitel 5 eine Reihe von positiven Effekten für Reim und Metrum auf den ästhetischen Genuss und die Verarbeitungsflüssigkeit. Gereimte Versionen von Sprüchen von Wilhelm Busch wurden als witziger empfunden und erhielten höhere Werte in positiver Valenz, Arousal, emotionaler Intensität und Prägnanz als ungereimte Versionen. Metrum hatte ebenfalls einen positiven Effekt auf die empfundene Witzigkeit. Außerdem wurden gereimte und metrische Sprüche schneller gelesen, was einen positiven Effekt der beiden Stilmittel auf die kognitive Verarbeitungsgeschwindigkeit nahelegt. Zusammenfassend unterscheiden sich die beiden vorgestellten Experimente auf mehreren Ebenen: während im fMRT-Experiment Techniken des Foregroundings den Leseprozess eher erschwerten und - obwohl sie Aufmerksamkeit erregten - nicht zur erhöhtem Gefallen beitrugen, zeigt die Experimentalreihe aus Kapitel 5, dass Foregrounding- Techniken die kognitive Verarbeitung erleichtern und sehr positiv beurteilt werden können.

Die Kernaussage der vorliegenden Arbeit ist, dass rhetorische und poetische Merkmale von Sprache (die durchaus auch in der Alltagssprache verwendet werden und nicht auf den engen Kontext von Literatur und Poesie beschränkt sein müssen) den Leseprozess beeinflussen und deswegen in der psychologischen Forschung weitaus mehr Betrachtung verdienen, als ihnen bislang zuteil wird. Die Ergebnisse der Experimente bestätigen eine zentrale Hypothese im Modell des literarischen Lesens (Jacobs, 2011), die besagt, dass die ästhetische Erfahrung von Text durch einen Wechsel zwischen zwei Arten des Lesens zustande kommt. Allerdings müssten die neuronalen Korrelate dieser Arten des Lesens angepasst

werden, denn die vorhergesagten Lateralisierungsunterschiede konnten nicht gefunden werden. Die vorgestellten Ergebnisse stellen erste Schritte hin zu einer neurowissenschaftlichen Untersuchung von ästhetischen Prozessen beim Lesen dar und sollen zu systematischen Folgeexperimenten motivieren, in denen die kognitiven und affektiven Effekte von Techniken des foregroundings spezifiziert werden. Bereits bei der Stimulus- und Aufgabenauswahl für solche Experimente sollten zukünftige Experimente in dem Bewusstsein geplant werden, dass stilistische, rhetorische und poetische Eigenschaften von Wörtern oder Sätzen den Leseprozess modulieren.

Summary

With a global literacy rate of ≈ 80%, the abilities to read and write are two of today's most important cultural achievements. Reading skills are required in a broad range of everyday routines, from reading the menu in a restaurant or the timetable at the bus-station to the task of understanding a highly formal letter in buerocratic interaction. Besides reading for information gain, a significant number of people across all societies frequently practice and enjoy reading for pure pleasure and/or because reading provides them a multifaceted emotional experience (Oatley, 1994). The scientific discourse about the esthetics of language and its application in poetry or rhetoric has a tradition reaching back to Aristotle. It is thus quite surprising that psychology - while offering elaborated models on visual word recognition (Coltheart et al., 2001; Grainger and Jacobs, 1996; McClelland and Rumelhart, 1981; Seidenberg and McClelland, 1989), sentence and text comprehension (Friederici, 2002; Graesser et al., 1994; Kintsch and Dijk, 1978), the development of reading skills and its clinical dysfunctions (Frith, 1985, 1986) - has little to nothing to say on affective and esthetic processes in reading. With the introduction of neuroscientific methods into experimental psychology and a re-gained interest in emotions over the last decades, a body of evidence has accumulated that highlights the role of affect in language processing (Briesemeister et al., 2011a; Citron, 2012; Silva et al., 2012; Võ et al., 2009, 2006). Still, this evidence has not yet entered the major theories of reading.

Likewise, despite growing interest in the investigation of esthetic judgments, experimental neurocognitive studies are available mainly for the domains of visual art perception, physical attractiveness, and music, whereas the esthetic evaluation of text in literature or poetry is eventually mentioned as a side note at the very best (Chatterjee, 2011; Nadal and Pearce, 2011). The model of Jacobs (2011) on literary reading is currently the only example of a model that connects behavioral results stemming from empirical studies of literature with a philosophical perspective and expertise on the functioning of the human brain. However, most of the postulates from this innovative model have not yet been experimentally tested. The main goal of this thesis was to test the central assumption of the model of literary reading, that literary reading is constituted by an alternation between two complementary modes of reading: (a) A mode of automatic "background reading" is described as reading expected, literal text, which mainly involves neuronal activity in structures in the fronto-temporal part of the left brain hemisphere. (b) A mode of "foreground reading" is proposed to take over when the reader encounters words or passages that are difficult to process and rather unexpected. Words could be foregrounded either because they stand out against the reader's prior reading experiences (a person's repertoire), contradict general knowledge, or the reader's current situation model (Kintsch

and Dijk, 1978), or because they are highlighted by stylistic techniques such as rhetorical figures and tropes. Foreground reading is supposed to be rather lateralized to the right brain hemisphere.

To investigate the mechanisms of "foreground reading" in this dissertation project, I performed a meta-analysis of the neural correlates of processing figurative language, conducted an fMRI experiment on semantic foregrounding and in a series of ratings and behavioral experiments I investigated effects of phonological and prosodic foregrounding with rhyme and meter. Although the tradition of rhetoric lists countless rhetorical figures and tropes, psycholinguistic research does almost exclusively focus on figurative language, especially on metaphors (Bohrn et al., 2012b). The meta-analysis presented in Chapter 2 therefore investigated whether functional neuroimaging studies on reading figurative and literal language point towards distinct modes of reading as proposed by the model of literary reading (Jacobs, 2011). Through a quantitative meta-analysis consistent differences between reading figurative and literal language were identified, however, no signs of lateralization were observed. Reading "foregrounded" figurative language in general, involved large parts of the left temporal lobe, bilateral inferior frontal gyri (IFG), medial frontal cortex, and the left amygdala.

In the fMRI experiment reported in Chapter 3 and 4 foregrounding was operationalized by varying the degree of predictability of single words in the context of familiar proverbs (Bohrn et al., 2012b). Inserting an unexpected word in a familiar proverb resulted in activation of the bilateral IFG and inferior occipital gyri (IOG), indicating that foregrounding elicits attention shifts to the foregrounded words. More specific effects of processing different types of foregrounding indicate that foregrounding on the sentence level (changing the meaning of the whole sentence), rather than on the single-word level (changing one word, without affecting the global sentence meaning) is associated with involvement of affect-related brain regions, such as the medial prefrontal cortex. The most important implication from this result is that there is not one mode of foreground reading but that different levels of foregrounding recruit at least partly different brain networks.

The results from the meta-analysis as well as from the proverbs-experiment imply that a mode of foreground reading is characterized by enhanced attention and stronger involvement of semantic regions, as text becomes more difficult to process. However, there were no signs of general esthetic preference for foregrounded text, unlike hypothesized in the model of literary reading. A parametric analysis of the data from the proverb-experiment nevertheless suggested that spontaneous esthetic evaluation of text takes place even during silent reading in the lack of an explicit esthetic judgment task.

While participants preferred the original familiar proverbs over foregrounded versions in the fMRI-Experiment, rating data in the experiment presented in Chapter 5 illustrate a number of advantageous effects for rhyme and meter on esthetic pleasure and processing fluency. The rhyming versions of couplets by Wilhelm Busch had higher ratings of funniness, positive valence, arousal, affective intensity, and poetic succinctness than the not rhyming versions. Meter positively affected funniness ratings as well. Also, rhyming and metrical verses were read faster, indicating positive effects of these stylistic features on cognitive processing fluency. In sum, the two experiments differ on several dimensions: whereas in the fMRI-experiment, foregrounding techniques complicated the reading process and - while capturing attention - did not result in stronger preference or more positive esthetic evaluation, the series of experiments described in Chapter 5 demonstrates that foregrounding techniques can ease cognitive processing and are evaluated very positive.

This thesis comes up with the conclusion that rhetoric and poetic features of language (that are by no means limited to the narrow context of poetry and literature) influence the reading process and deserve much more attention from a psychological perspective than they have received so far. The results confirm a central assumption of the model of literary reading (Jacobs, 2011) that esthetic evaluation of written text is influenced by a shift between modes of foreground and background reading, although the neuronal correlates of these reading modes probably need updating, as no indication for lateralization effects was found. When selecting stimuli and tasks, future psychological research on the esthetic processing of text should be aware that stylistic, rhetorical, and poetic variables influence the reading process. These results call for a more systematic investigation of cognitive and affective effects of foregrounding techniques on the reading process.

Contents

1. Introduction

The ability to read and write is one of the greatest cultural achievements of humanity. Today we are constantly surrounded by written text. As skilled readers we read daily and perform this task automatically and effortlessly. To get an idea about how complex reading is, one has to watch a child that has just started discovering the use of letters, who is trying to read a word. While initially learning to read is a tedious and time consuming process, many people finally reach a level of expertise that makes them unable to look at a word and not read it (Stroop, 1935). Among adults there is now a global literacy rate of $\approx 80\%$ and it is even higher in industrialized countries (CIA, The world factbook; https://www.cia.gov/library/publications/the-world-factbook/index.html - accessed Oct 2012). Because reading skills are required in a broad range of everyday routines, people who can not read are facing social exclusion. Reading competence is expected for understanding the menu in a restaurant, the timetable at the bus-station, or a highly formal buerocratic letter.

But even among literate people there is huge interindividual variance not only concerning reading competence but also concerning reading habits. Some people hardly ever read at all and try to avoid reading-related situations, others only read for practical reasons, e.g. for the purpose of communication or orientation, again others enjoy reading for pleasure and spend a great part of their leisure time lost in in novels, literature, or poetry. A skill that is mastered by so many people while at the same time showing such massive interindividual variance is of natural interest for psychological science. Over the past 100 years psychological research has contributed much to describe and explain the process of visual word recognition. Several models describe how the brain succeeds in processing these *a priori* arbitrary symbols and recognizes them as meaningful words (Coltheart et al., 2001; Grainger and Jacobs, 1996; McClelland and Rumelhart, 1981; Seidenberg and McClelland, 1989). Psycholinguistics offers models of (auditive) sentence- and textprocessing (Friederici, 2002; Graesser et al., 1994; Kintsch and Dijk, 1978; Zwaan and Radvansky, 1998). Elaborated models exist on how the eye-movements, which are an integral part of natural reading (you probably move your eyes about 3-5 times per second while reading this sentence) are performed and controlled (Engbert et al., 2005; Just and Carpenter, 1980; Rayner, 1998; Reichle et al., 2004). Developmental psychology differentiates be-

tween levels of competence that have to be mastered in the process of reading and writing skill acquisition (Frith, 1985, 1986) and how failures in mastering one of them result in reading disorders. The following pages will give an introduction into the psychology of reading and will make evident how complex already the task of reading single-words can be. Models of sentence or text reading naturally have to deal with an even greater amount of complexity, as predictability, syntax, and narration come into play.

Anyone who has ever read a hilarious novel, a thrilling crime story or a passionate romance will confirm that the reading experience can cover a broad spectrum of emotions (Oatley, 1994) which might for some people even be the main motivation to read at all (Altmann et al., 2012b). But already single words have an affective connotation, and a sometimes very intense one, as in the case of taboo words (Briesemeister et al., 2011b; Võ et al., 2009, 2006). A growing body of empirical evidence from the past ten years suggests that affect and emotions shape the reading process (Citron, 2012). These findings will be elaborated in the course of this chapter. However, the role of affect and emotions in reading has long been underestimated and is still not incorporated in current psychological models of reading. The first model that does link behavioral results from empirical studies of literature with a philosophical perspective and expertise on the functioning of the human brain is the model of literary reading (Jacobs, 2011). The model describes and qualitatively predicts how the subjective reading experience as well as objective behavior and brain activity are shaped by the stylistic patterns of a prose text.

1.1. Psychological reading models

Proficient readers perform many tasks while reading: They move their eyes across the page, identify words, process semantic, orthographic, phonological and syntactic information, activate prior knowledge, re-read passages, build up anticipations, correct them, and so on. Because the process of reading and understanding words, sentences and text involves so many top-down and bottom-up processes, there is no single psychological theory that could explain all phenomena but several models, which focus on separate aspects. Speaking in terms of human evolution reading and writing are rather recent cultural techniques that may have been invented some 5000 years ago. In contrast to speaking, evolution thus did not have the time to develop specific reading brain parts (Pinker, 1994). Accordingly, reading is a highly artificial and unnatural task so the process of reading skill acquisition typically does not start until middle childhood and it takes some years and massive specific teaching until a child has mastered all necessary skills. In the standard model of reading acquisition (Frith, 1985, 1986)

the child passes three stages. On the logographic stage the child processes words as icons or visual object. It might recognize frequent or salient words, such as a brand name on its favorite chocolate but it would fail to recognize the word in another font. On the alphabetic stage, the child has explicit knowledge of the phonological elements (phonemes) that constitute a word, as well as of specific letters and knows how letters correspond to sounds. It can read in a letter-by-letter fashion by first sounding out single letters and then merging these sounds into words. Only after reaching the orthographic stage, word-part or whole-word representations are stored in an orthographic lexicon and their meaning can be accessed without going through grapheme-phoneme conversion.

For proficient readers basic visual word recognition is an automatized process that cannot be turned off even if it interferes with other cognitive tasks. For instance, it is difficult to name the red color of letters that form the word "green" (Stroop, 1935). But proficient readers are able to read not only frequent, common words, such as "house" or "love" but also pronounceable non-words, such as "lirf" or "trun". Moreover, they have no trouble reading words that are pronounced irregularly, such as "pint". While frequent words might be recognized in a holistic manner (for instance, one might instantly recognize the word "TAXI" on a car without having to merge the sounds of the individual letters into a word), other words require identification of letters or other sublexical units to recognize a word. Typically, lexical access to visually presented single words is investigated using the lexical decision task, introduced by Rubenstein et al. (1971). Both, for the task of pronouncing a written word as well as to access the lexical meaning of a written word, dual-route models (Coltheart et al., 1993, 2001) are widely accepted models (Jobard et al., 2003). They generally assume two pathways from the written word to pronunciation or to access of the lexical meaning: one fast lexical route (direct route) is supposed to be used for the pronunciation and lexical access of regular words. Via the lexical route, words directly activate entries in a hypothetical mental lexicon from which stored knowledge about the pronunciation and semantic meaning of words is retrieved. This route can e.g. explain the correct pronunciation of homographs (e.g. "tear"). The non- or sub-lexical route is supposed to be an alternative route used for reading words that are not stored in the lexicon. Rather than having direct access to the word, each grapheme is mapped to a phoneme using correspondence rules. Such a sub-lexical route is e.g. suited to explain the pronunciation of new or non-words by phonological recoding. There exist a great number of alternative models from flow-charts to connectionist models that, with varying degrees of complexity and specification, provide explanations for the lexical access of visually presented words (for reviews see Jacobs and Grainger, 1994 or Barber and Kutas, 2007).

Already the lexical access of single words is a process that is not yet fully understood. However, we typically encounter words in the context of sentences and text. On the level of sentence reading syntactic processes as well as a reader's background knowledge influence a reader's interpretations of meanings of sentences. This is important because many sentences have multiple meanings and some are very ambiguous, such as the famous Chomsky-example "Flying planes can be dangerous". To understand such a sentence, the reader has to consider contextual variables, knowledge about the writer of the sentence and eventually prior knowledge. A reader continuously makes predictions about the upcoming words that are shaped by bottom-up variables (e.g. parafoveal preview that informs about the length of the next word) as well as by top-down variables (Dambacher and Kliegl, 2007; Dambacher et al., 2006, 2009). A cryptic text about seemingly unrelated acts can be read much faster if the reader knows in advance that it is a description of washing laundry. The text is understood faster with the appropriate schema activated in mind (Anderson and Pearson, 1984; Brandsford and Johnson, 1972).

Text reading not only involves extracting meaning explicitly stated, but it has a strong constructivist component. According to Carrell and Eisterhold (1983), frequent readers own schemata on several levels: Linguistic schemata include (implicit) knowledge about syntactic structures, word (co-) occurances, etc. Content schemata are not specific to reading and contain general semantic knowledge, but also beliefs or values. Formal schemata contain expectations about the genre-specific structure of a text. Probably in every reading situation readers will interpret a text rather than decode it, not only when reading literature or poetry. They will rely on background knowledge, assumptions about the author's goal, and the situation in which it was written. Pearson et al. (1992) focus on this aspect when they describe the "thoughtful reader" in very active terms as a planner, composer and editor while reading a text. Likewise, even poor readers can speed up visual word recognition if they compensate by using knowledge about the text for guessing (Stanovich, 1980). Interactive reading models recognize that bottom-up and top-down information are used flexibly during reading in an interactive way (Carrell et al., 1988; Just and Carpenter, 1980; Rumelhart, 1977; Stanovich, 1980). Readers receive information via visual input and compare it to expectations they had, based on background knowledge. They will try to integrate the novel information into their prior concepts. Matching information can speed up reading and keep it fluent, unexpected or mismatching information can reduce comprehension. According to Just and Carpenter (1980) reading times for words, clauses, and sentences are a function of word properties as well as of top-down variables. Eye-movements are connected to text comprehension via the assumption that readers fixate a word until they have processed it.

Situational models are an influential type of cognitive models on how readers comprehend the narrative structure of a text and on how they make inferences (Kintsch, 1988, 1994; Kintsch and Dijk, 1978; Zwaan and Radvansky, 1998). In this type of model, focus is put on the active role of the reader in understanding a text. Apart from extracting logical information about what happens when, where, why and to whom, readers are likely to connect information across sentences by building up a situational model and update it continuously by using grammatical knowledge and world knowledge. The five dimensions that are typically assumed to constitute the situational model are time, space, causation, intentionality, and protagonist (see Zwaan and Radvansky, 1998 for a review). These models have been used to explain memory effects, differences in reaction time, and in response latencies. The seminal papers referenced above do not mention emotions in the context of text comprehension. Neither do they consider emotions that are mentioned in a text, nor affective response in the reader. In an extension of the original model (Kintsch and Dijk, 1978), Kintsch (1980) acknowledges the importance of interest as a driving force when reading a story. He explicates factors that influence the interest in reading a story, which are prior knowledge, surprise, personal importance, and how much the story makes sense for the reader. Although Kintsch is explicitly talking about a cognitive (not emotional) form of interest that arises when expectations in the reader are modified (be it through stylistic, syntactic, or semantic mismatch with prior expectations), there are good reasons for considering interest as a category of emotion (Silvia, 2008). Moreover, Oatley (1994), describes very similar processes of schema assimilation and accomodation when referring to emotions in literary response, specifically talking about curiosity and surprise. In contrast, I consider less important the question, whether interest and curiosity should be labeled cognitive or affective phenomena, such terminological difficulties frequently occur when investigating emotions. So before deepening into affective processes in reading, I will give a general introduction into psychological research of emotion.

1.2. A psychological perspective on emotions

After more than 100 years in which psychologists have been trying to discover the nature of human emotions, there is a vast number of psychological emotion theories and models but still no satisfying definition of what emotions are and how emotional experience influences human behavior and cognitions. Categorical and dimensional views of emotions argue about the number and type of emotion categories. Categorical theories assume a fixed number of basic emotions such as fear, anger, happiness, surprise, disgust and sadness (although number and labeling of these categories differ substantially between theories) that are believed to be universal and innate (e.g. Ekman, 1992; Levenson, 2011) In

contrast, the dimensional view stands in the tradition of Wundt's three factor theory (Wundt, 1922). Wundt described emotional experience on the bipolar dimensions *pleasant/unpleasant*, *high/low arousal*, and *concentrated/relaxed attention*, assigning emotions a hedonic quality, an intensity, and a dimension in time. Likewise, when statistical factor analysis was applied to semantic differentials (Osgood et al., 1957; Russell and Mehrabian, 1977) valence, arousal and potency were identified as the three underlying core dimensions of attitudinal behavior and emotional states. The practical advantage of dimensional models over categorical models is its efficiency in measuring affective with only a few scales. With the circumplex model of affect, later Russell (1980) preferred a model reduced to only two independent, bipolar dimensions, namely valence and arousal. On theoretical grounds certain assumptions of the two-dimensional model can be questioned, for instance, if valence and arousal have equal predictive value for subjective emotional experience (Barrett, 2006). The model has also been critizised for assuming a bipolar structure of valence. Treating positive affect and negative affect as two independent unipolar dimensions allows for the description of mixed emotions (Watson et al., 1988; Watson and Tellegen, 1985). Bipolar and unipolar models are equally well suited to explain reports of subjective emotional experience (Russell and Carroll, 1999). For the rating of the affective quality of the stimuli used in the experiments, I wanted to rely on empirically well approved measures. Thus, based on the circumplex model (Russell, 1980), bipolar scales of valence and arousal from the well established SAM instrument (Bradley and Lang, 1994) were chosen, which had been successfully used for characterizing affect induced by single words before (Võ et al., 2009, 2006).

How do the human body and brain create emotional experience? The question leads back to the origins of psychological theories of emotion, when William James asked the central question: "Do we run from the bear because we are afraid, or are we afraid because we run?" Feedback theories (James, 1884; Schachter and Singer, 1962) answer this question by arguing that emotional experience is determined by peripheral feedback, such as the perception of changes in heart rate, breathing rate, perspiration, and hormone levels. Only if these changes are interpreted and some reason for the bodily arousal can be found, we do experience emotion (in simple words: we feel sad, because we notice that we are crying). Currently, this position is taken up again by Damasio (2003) who claims that the bodily changes come prior to the conscious experience and that affect is grounded in bodily experience. The oppisite view was proposed by Lazarus (1982) claiming that reasoning and interpretation of a situation have to precede the emotional and physiological reaction. According to him, the evaluation of a situation's relevance influences all following emotions. If somebody knows that the performance is going to be evaluated, this person starts feeling nervous. From this position other cognitive appraisal theories developed (Schachter and

Singer, 1962; Scherer, 1982, 2001). Schachter and Singer (1962) highlighted the physiological component of emotions by claiming that physical arousal was a necessary prerequisite of emotions. Appraisal theories reach consent on the notion of emotions resulting from evaluations of the accomplishment of one's goals. Satisfaction of goals promotes positive emotions, whereas negative emotions arise if somebody's goals are not satisfied. Frijda (1988) had drawn together many insights from emotion research and formulated twelve "laws of emotion", which, though not to be considered "laws" in a logical sense, cover a wide range of emotion phenomena and emotion mechanisms. He also emphazised the role of cognition in emotion generation. Although certain situations have a high probability of eliciting specific emotional reactions, the personal interpretation as well as current goals, motives, and concerns determine the emotional outcome.

An affective neuroscience approach is provided by Jaak Panksepp (2005, 2006), who - speaking from a psychobiologist's perspective - breaks down emotional experience into emotional core systems that humans share with all other mammals. According to him, emotional reactions and also many basic cognitive functions can be explained by the involvement of core affect systems, namely: play, fear, lust, care, seeking, rage, and grief/panic. This theory is based on parallels in the human and the mammal brain, therefore it makes specific hypotheses on the subcortical brain circuits, hormons, and neurotransmitters regulating basic emotional experience. Although there is evidence for these basic emotion systems (Panksepp, 1998), it has yet to be determined to what extent these basic emotional processes are also involved in highly artificial and culturally shaped tasks such as reading that always involves the cortico-cognitive brain systems. This is easier said than done, because unlike in animal studies, ethical constraints often prevent direct manipulation of the human endocrine or neurotransmitter system. Furthermore, although certain subcortical structures have been traditionally linked to specific basic emotions (e.g. amygdala to fear), the neuronal signatures of emotions are not that specific. For instance, the amygdala is activated by positive and negative emotions (Costafreda et al., 2008) and as learning and culture provide humans with greater control over emotional systems, it becomes very difficult to disentangle cognitive from affective components. For instance, the amygdala reaction to fearful faces is diminished when attentional load is high (Morawetz et al., 2010). It is thus very difficult to conclude from indirect measures of neuronal activity alone on the presence of emotional states. When it comes to human emotional experiences, in most cases scientists have to rely on verbal reports, such as ratings or emotion labelings.

The fact that it is often difficult to infer about the emotional state of others without verbal communication already highlights the interconnection of language and emotion in humans. It is thus surprising that traditionally emotion theories and language models have developed independently, hardly ever informing each

other. The last five years of research within the DFG-funded cluster of excellence "Languages of Emotion" (FU Berlin) have demonstrated that this interconnection of language and affect can be illuminated from different disciplines and on many levels, touching verbal and non-verbal language in humans and animals. Only recently have Reisenzein and Junge (2012) published a theory on language and emotion in the light of his computational belief-desire theory of emotion (CBDTE). Although emotions undeniably have strong physical components, the CBDTE and other cognitive emotion theories (Frijda, 1988; Scherer, 2001) consider thought, reason, and interpretation as essential preconditions of emotions. The core assumption of the CBDTE is that emotions depend on beliefs (cognitive states) and desires (motivational states). Novel imformation is supposed to be preconsciously compared to prior believes and desires emotions are computated from match or mismatch within the belief-desire system. For example, if Peter desires his friend to recover from illness but is uncertain about the well-being of his friend, he will experience fear. If now he comes to believe that his friend is recovering, he will feel happy. CBDTE is able to explain type and intensity of basic emotions (happiness, unhappiness, hope, fear, surprise, disappointment, and relief) as well as "moral emotions". Important for affective processes in reading, Reisenzein and Junge (2012) claim that the theory in principle also accounts for emotional reactions to fictional events, for instance when we read about the beliefs and desires of a character, we make hypotheses of their emotional states. However, according to Frijda's "law of apparent reality", the intensity of emotions to fictional events should depend on how "real" and vivid they are in the reader's perception. According to the CBDTE, natural language is not only important in communicating emotions to others, it also plays and important role in emotion generation, because the beliefs and desires constituting an emotion are coded in language-like mental representations. Moreover, human beliefs and desires are mainly formed through verbal communication, thus turning natural language into the most important source of emotions. My personal interest is in the role of affective and esthetic processes in reading, therefore the role of affect in spoken language will not be an issue of this dissertation. Instead, the following section will focus on the role of emotions in reading.

1.3. Emotions and Reading

Words have emotional connotations that can be described on the dimensions of valence and arousal. While some words directly refer to emotional reactions or affective states (*anger, joy, shame*) also all other words are potentially associated with emotional reactions. A word's potential to elicit an affective response is usually determined by large rating studies in which valence and arousal are assessed (Briesemeister et al., 2011b; Võ et al., 2009, 2006). Although it is questionable, if

such a thing as a "neutral word" can exist, such rating databases allow for grouping words into classes of positive/negative/neutral or high/low arousing stimuli. A number of facilitatory but also inhibitory effects of words that load high on positive or negative valence and arousal relative to more neutral words have been reported and are described excellently in a recent review by Citron (2012). Emotional information-processing concerning word material has been shown to speed up the time course of visual word recognition (Kousta et al., 2009; Kuchinke et al., 2005). Two event-related components in the EEG are associated with emotions: The early posterior negativity (200-300 ms after stimulus onset) is larger for words with high arousing pleasent or unpleasent content and probably reflects an early orientation towards emotionally relevant content that facilitates lexical access (Kissler et al., 2009). A late positive complex (500-800 ms after stimulus onset) in a time frame in which more elaborated cognitive processes take place is also sensitive to valence. However, results regarding the amplitude differences between positive, negative and neutral words are very mixed and probably depend on the salience of words in a specific stimulus set (Citron, 2012). FMRI experiments from the last ten years suggest that emotional information processing of words relies on cortical and subcortical structures that are generally involved in processing emotions, such as the ACC, medPFC, insula and amygdala. However, the studies available differ in task and in how well these stimuli were matched on lexical dimensions, thus, valence and arousal are often confounded with other variables. Emotion inducing content undoubtedly influences the processing of written words, although the localization, timecourse and size of the effect seem to be stimulus- and task-dependent.

Apart from the emotional connotation of words, also the reader's mood is known to influence visual word recognition. For instance, people are faster at recognizing written words with a mood-congruent connotation (Niedenthal and Setterlund, 1997). This heterogeneity of results might explain why emotion variables have not yet been introduced into models of visual word recognition. The relevance of emotions on the reading motivation is recognized by applied developmental psychologists and has important implications also for the teaching of reading. An empirical study by Senechal (2006) indicates that in children the subjective pleasure in reading is positively correlated with reading competence and it is likely that language competences and emotional competences are tightly connected during middle childhood (Beck et al., 2012).

The results outlined above were relevant for the experiments conducted in this dissertation, because they prove that emotional processing of word material influences word recognition even on the single-word level. Affective variables thus add to the huge list of factors already known to influence word recognition (Graf et al., 2005). The investigation of affective and even esthetic processes in single words with the attempt to control for all potentially confounding lexical,

sublexical, and affective variables would be challanging enough for many years of research. My special interest was and is, however, the investigation of estetic emotions. I find it fascinating how authors seemingly intuitively manage to guide my attention over many pages or how a well-formulated sentence or piece of lyric can elicit strong emotional reactions and makes one re-read certain passages over and over again. Some stylistic effects can be observed even on the single-word level, as colleagues and I have demonstrated in an experiment on metaphors in noun-noun compounds (Forgacs et al., 2012), but the options for stylistic manipulations in single words are very limited. Often, rhetorical figures and tropes require space, because they cover several words or sentences (Miall, 2008). As a compromise between single-word and whole stories or novels, the phrase and sentence level was chosen for the stimuli in all studies of this dissertation project. This short format would hardly be suited for investigating affective phenomena like the reader's immersion into the world of the text (see section 1.5), neither does is contain enough information to create empathy with a character, unlike in reading stories (Oatley, 1994). In contrast, the sentence format is perfectly suited for investigating effects of isolated rhetorical figures and tropes as will be shown for semantic deviations (chapter 3), figurative language (chapter 2), and phonological figures (chapter 5). The reader unfamiliar with empirical esthetics might consider it utopic to tackle esthetic processes in reading with empirical and neuroscientific methods. Therefore, the following section will recapitulate the long tradition of empirical esthetics in psychology.

1.4. Empirical esthetics and neuroesthetics

Ever since the work of Gustav Theodor Fechner (1801-1887), the founder of psychophysics and one of the fathers of empirical psychology, esthetics have been the object of empirical research. Still, there is no consensual definition of the term "esthetics" in psychological research. The terms "liking", "preference", "esthetic evaluation", and "beauty judgment" are often used interchangeable. In a recent review on neuroesthetics Anjan Chatterjee suggested to use the term "esthetics" in a broad sense "to encompass the perception, production, and response to art, as well as interactions with objects and scenes that evoke an intense feeling, often of pleasure" (Chatterjee, 2011, p. 53). Fechner called for "bottom-up esthetics" in which the nature of esthetic experience was not to be explained by philosophy alone but also by experimental methods. He himself conducted experiments e.g. on the nature of the "golden ratio". Around the turn of the last century, the school of Gestalt psychology with popular members Christian von Ehrenfels, Max Wertheimer, Kurt Koffka, Wolfgang Köhler and Kurt Lewin formulated laws of perception focusing on the entirety of objects. They described how our senses generate the perceptions of objects according to laws of grouping

through similarity, proximity, symmetry or closure. The reduction of complexity was identified as an important quality of human perception, accomplished by the tendency of the brain to perceive complex patterns in terms of objects/figures and background. A "Good Gestalt" was meant to elicit positive esthetic evaluations because of a high degree of "Prägnanz" (engl. succinctness).

After the second world war Canadian Daniel E. Berlyne introduced the "new experimental esthetics", and in his work he focused on stimulus characteristics such as complexity, ambiguity, novelty, and familiarity. He postulated that a combination of these stimulus characteristics would define the arousal potential of a stimulus and he frequently found a curvilinear relationship between arousal and hedonic preference (Berlyne, 1960). Although the relevance of these variables for esthetic evaluations has been shown numerous times, data concerning the direction of the effects are mixed. Zajonc (1968) introduced the "mere exposure effect", emphasizing how people prefer items simply because they are more familiar to them than others. Kunst-Wilson and Zajonc (1980) demonstrated this effect even in the absence of conscious perception. Martindale and Moore (1988) and Martindale et al. (1990) coined the "preference for prototypes" effect: people prefer items if they are easily identifiable and close to a prototypical object of a category. According to all these theories there is a relationship between cognitive processing effort and esthetic evaluations. The theory of hedonic fluency (Reber et al., 1998) basically predicts a positive hedonic quality for objects, which are easy to process (objectively or subjectively). In contrast to idealized experimental conditions, in a real-life situation multiple context-, person- and stimulus-variables determine the esthetic evaluation. The model of Leder et al. (2004), depicted in figure 1.1, includes most of the variables discussed in the psychological literature of esthetic perception and organizes them into a process-model of esthetic appreciation and esthetic judgments.

The central elements of the model are five stages of processing a visual artwork. The result of this process is an esthetic judgment about the quality of the artwork as well as an esthetic emotion. These five stages start with basic visual processing and implicit memory integration. At a higher cognitive level, explicit classification of the object in terms of style and content takes place. At this point challenges and ambiguities occur and are eventually cognitively mastered. This process of cognitive mastering leads to interpretations on which the final evaluation is based. The model makes predictions on the time-course of esthetic evaluations as well as on differences between groups of perceivers. Thanks to experimental testing of the model with behavioral experiments as well as with EEG (Lengger et al., 2007) and pupillometry (Kuchinke et al., 2009), the temporal dynamics of art perception are now better understood. Descriptive content information seems to be processed prior to stylistic information and more elaborated understanding (Augustin et al., 2011, 2008; Leder et al., 2006). Im-

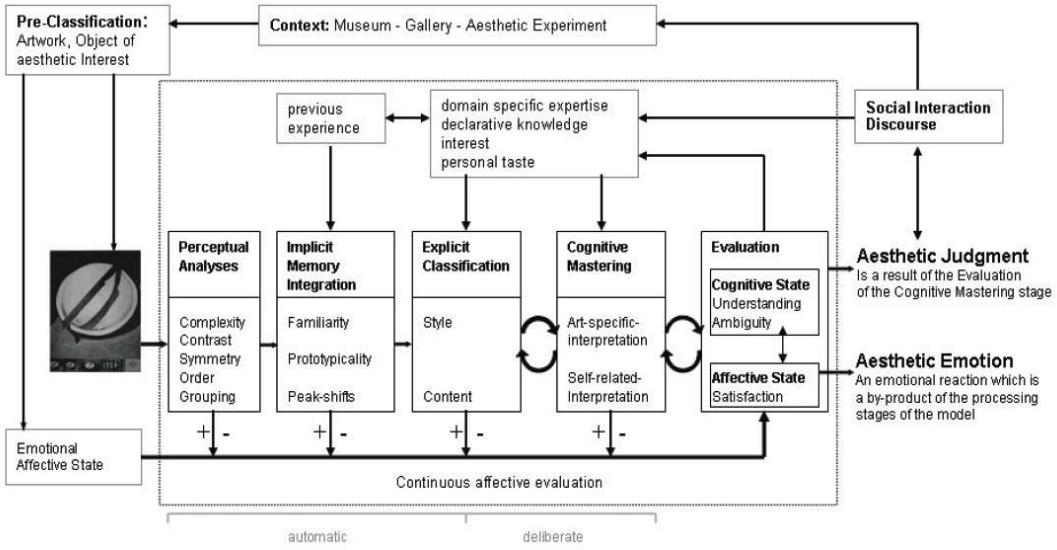

Figure 1.1.: The process-model of esthetic perception by Leder et al. (2004) includes five stages of art processing. Based on automatized perceptual analysis, implicit memory integration, and explicit classification of an artwork in terms of style and content, more deliberate stages take place. Ambiguities can be cognitively mastered with the help of art-specific knowledge and self-referential interpretations. The result of a final evaluation stage are a cognitive esthetic judgment and an esthetic emotion

portantly, the level of art expertise significantly influences art perception (Leder et al., 2006). In non-experts, the emotional response towards an artwork is highly correlated with the ability to understand an artwork whereas these variables are more independent in expert viewers (Leder et al., 2012; Lengger et al., 2007), who might appreciate a higher level of ambiguity in art (Jakesch and Leder, 2009). In contrast, non-expert viewers seem to prefer photographic pictures and artworks that are easy to process (Kuchinke et al., 2009). Fluency can be based on perceptual qualities, such as contrast and sharpness (Tinio et al., 2011), or on congitive factors, such as explanatory title information (Belke et al., 2010). Although the model was originally specified for the perception of visual modern art, it provides a good general overview of relevant variables and can potentially be transferred into other domains. Especially the preference for fluent to process and easy to understand stimuli can be easily tested with other stimulus domains, such as music and written words and is therefore of high relevance for the topic of this dissertation.

With the introduction of neuroscientific methods such as EEG and fMRI into psychology, research on esthetic perception and esthetic preference has received renewed attention in the last decade. In particular the hedonic value and the possibility of self-reward make esthetic experience a relevant object of affec-

tive neuroscience. The neuroimaging studies currently available investigate the esthetic perception of visual art (Cupchik et al., 2009; Kirk et al., 2009b; Vartanian and Goel, 2004), abstract geometrical patterns (Jacobsen et al., 2006), faces (Aharon et al., 2001; Ishai, 2007; Winston et al., 2007), music (Blood and Zatorre, 2001; Ishizu and Zeki, 2011; Koelsch, 2010), architecture (Kirk et al., 2009a), or dance movements (Calvo-Merino et al., 2008). Despite huge heterogeneity in task and stimuli, evidence points towards esthetic perception being based on sensorimotor areas, emotion networks, and reward-circuits in the brain. The lack of neuroimaging studies on esthetic processing of word material inspired the analysis of parametric beauty-related brain activations discussed in chapter 4. In general, the exploration of esthetic processes in reading is still in its infancy. A possible concern against the investigation of esthetic processes in reading could be that not all predictions from the domain of visual esthetics are easily transferable to the domain of written words. While certain key variables such as familiarity, complexity, content and style from the Leder model could potentially be translated into the domain of literary reading, the act of processing a visual artwork also differs in important points from reading a literay text. For instance, the sequence in which a reader accesses information is determined by the text, while in visual esthetics all information are potentially available at the same time. Thus, a reason for the lack of studies on esthetic processes in reading could be the absence of models that allow predicting behavior, experience and neurophysiological correlates of esthetic processes specific to reading. The following section will give an introduction into a model which aims at closing this gap.

1.5. The model of literary reading

This section will introduce the reader to the model of literary reading shown in figure 1.2 (Jacobs, 2011). It was developed to make predictions concerning behavioral responses as well as neuronal responses of readers who process literary prose. The model integrates the notions of the Russian formalists (Shklovsky, 1998) and Czech structuralists (Mukarovsky, 1964) as well as on hypotheses proposed by literary scholar Wolfgang Iser (Iser, 1978). Instead of trying to give a definition of what characterizes poetic language (a hopeless endeavor), it combines empirical evidence and philosophical as well as neuroscientific perspectives to describe literary reading. Unlike (mainstream) models of literary criticism it holds a psychological perspective by focusing on the reader and on the reader's reactions instead of analyzing only the text. The result should be an experimentally testable model. Ultimately, such a model could predict what text characteristics cause which type of reader-reactions in terms of behavior, subjective experience and brain activity. However, given the limited amount of

empirical data currently available, the model in its present form as a descriptive "neurocognitive working model" (Jacobs, 2011, p. 494) is obviously much too complex and unspecific to allow selective hypothesis testing. Nevertheless, it provides for the first time a very useful collection of most of those variables discussed in the literature as influencing the process of literary reading.

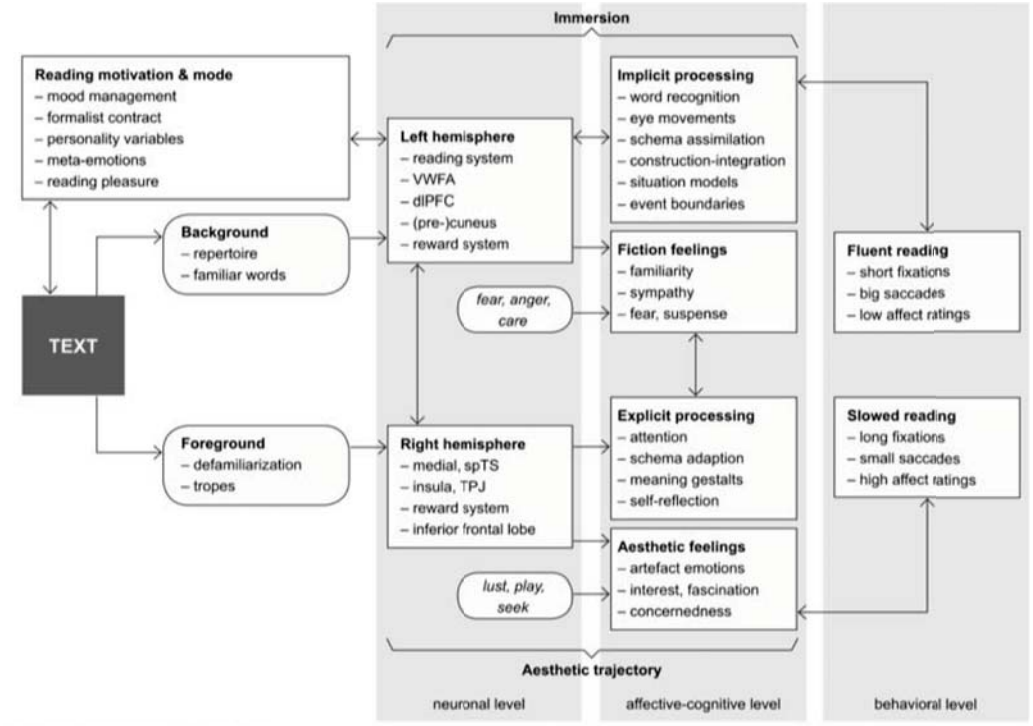

Figure 1.2.: Model of Literary reading - The upper half of the model describes the fast route of background reading when processing relatively easy text material and familiar content. The lower half covers the slow route of foreground reading and the process of an esthetic trajectory that takes place when the reader encounters defamiliarized text passages and rhetorical tropes. The model characterizes both routes on the neuronal. affective-cognitive, and behavioral level.

Despite the modes's complexity it can be organized into several key elements. First, there is the perspective of the reader prior to reading the text. Personality traits, reading habits, moods, reading competence and expertise as well as the context in which a text is read might all shape the reading experience or might decide if a person starts reading a text at all. Experiments with between-subject designs (e.g experts/lay people), mood inductions, or varying reading context could be imagined for testing this aspect of the model. Partly this is currently done in other units of the project on affective and esthetic processes in reading within the cluster "Languages of Emotion" from which this dissertation evolved. Altmann et al. (2012a) could show distinct brain networks for reading text de-

pending on whether readers thought a text to be based on factual or on fictional events. Such context and personality effects will, however, not be part of this dissertation.

The rest of the model can be broken down into a core structure resembling the dual-route models of visual word recognition described in section 1.1. As a central assumption of the model, reading a text is either performed via a fast, automatic route of literal, "background" reading or via a slower route of "foreground" reading. What is called background reading here covers the major part of reading as discussed in psychological literature. It includes the highly automatized part of fluent reading, that is word recognition, sentence processing, prediciton of upcoming events, building up a situational model, eye-movement control etc. In such a mode of reading, eye movements are typically fast, with short fixations. On the neuronal level background reading is localized in the LH reading networks, including visual word form area, Broca and Wernicke center, and the dorsolateral prefrontal cortex. Text elements that match a reader's predictions, are familiar to the reader, and conform to the reader's repertoire are likely to keep the reader in this mode of reading that is supposed to be characterized through rather low ratings on affect scales.

What constitutes one outstanding character of the model of literary reading against other models of text processing is the prediction of continuous affective processing of a text. Even the rather implicit mode of background reading is proposed to be accompanied by feelings, albeit non-esthetic ones. Those are speculated to be general positive feelings, related to the correct predictions and met expectations. Specific to literary text is the phenomenon of immersion, supposed to take place as the reader "enters" the fictual world, feels empathy or sympathy for characters, and experiences emotions in response to events that take place in the fictual world. Another unique point of the model of literary reading is its connection to the core affect systems described by Panksepp (2006). Background reading is proposed to be tendentially driven by the fear-, care-, and anger-systems. While the neuronal and behavioral correlates of implicit background reading are quite well researched, the part of the model concerning non-esthetic feelings and the role of core affect systems is yet highly speculative and calling for experimental testing, especially as this part of the model is not within the focus of my dissertation.

Instead I will focus on the route of "foreground reading", which is supposed to be taken primarily if the reader encounters unexpected, novel, or rhetorically foregrounded elements in a text. The model of literary reading includes several options of why parts of a text can be foregrounded: In line with schema-theory (Anderson and Pearson, 1984; Bartlett, 1932; Carrell and Eisterhold, 1983; Piaget, 1926; Rumelhart, 1980) elements not matching a reader's predictions, be it

in terms of semantic information, values, beliefs, linguistic structure or rhetoric composition, are potentially salient. They are preferably read via the slow route of foreground reading. The organisation of reading into foreground- and background reading is per se not limited to literary reading. Also in non-literary texts readers encounter unexpected, difficult to process passages. In fact, most literary text might be much easier to understand than the manual of a standard washing machine. What makes the model specifically applicable to literary text, is that authors often deliberately use rhetorical strategies of fore- and backgrounding to guide readers' attention and to elicit esthetic and emotional reactions. The concept of foregrounding information in a text, by semantic or linguistic markers, has been discussed by Zwaan and Radvansky (1998).

Of all these diverse stimulus characteristics, figurativeness is the empirically best investigated one. The two major theories in the field of experimental metaphor research are the coarse-semantic coding theory (Jung-Beeman, 2005) and the graded salience hypothesis (Giora and Rachel, 1997). Both predict stronger right-hemispheric activation for processing figurative language. However, current findings concerning the lateralization of figurative language (i.e. metaphors, idioms, irony) are mixed. According to the model of literary reading, foreground reading generally involves more RH networks than background reading. This hypothesis are adressed in a review and meta-analysis of neuroimaging findings on the processing of figurative language, provided in chapter 2, as well as an fMRI experiment dedicated to semantic foregrounding (see chapter 3).

Esthetic processing is implemented in the model as a temporal dynamic in the form of an esthetic trajectory (Fitch et al., 2009). Esthetic emotions are expected to be based on the process of encountering passages which mismatch expectations, recognizing them as such, and resolving them (Miall and Kuiken, 2000). According to the model this process is expressed on the behavioral level in terms of slower reading times, longer fixations, and more extreme ratings on affect scales. Therefore, ratings of affective dimensions (valence, arousal, intensity) and of esthetic qualities (beauty, poetic succinctness) were central dependent variables in the experiments presented in the following chapters. Relating to Panksepps core affects, reading foregrounded text is supposed to recruit the lust-, play-, and seek-system. Again, this part of the model is speculative. Others, however, are already backed up by behavioral data. The following section will summerize the main results concerning foreground reading reported so far and in this context will introduce the experimental paradigm of *derhetorizing*.

1.6. Empirical studies on foregrounding

Although literature and poetry are ancient artistic disciplines and have the potential to elicit a wide range of esthetic feelings (Frijda, 1988; Miall, 2008; Oatley, 1994; Reisenzein and Junge, 2012), only few empirical studies so far have directly investigated affective and esthetic processing of text. Those studies available are to a large part the merit of members of the IGEL (Internationale Gesellschaft für Empirische Literaturwissenschaften; International Society for empirical studies of literature). Some experiments directly tested the hypothesis that foregrounded text is read slower and with higher affect than backgrounded text. Van Peer (1986) presented participants with lines from poems and they gave the highest ratings of strikingness to the lines containing the most foregrounding elements, thereby supporting the foregrounding hypothesis. These results were replicated partially even by only presenting single lines (Van Peer et al., 2007). Similar effects have been found for larger text units in the form of literary stories by Miall and Kuiken (1994), who measured reading times and found that foregrounded paragraphs were read slower and were rated with stronger feelings of strikingness and general affective involvement than less foregrounded passages. In the studies of Miall (2008); Miall and Kuiken (1994) "natural" text material with sufficient variance in foregrounding was selected and analyzed in terms of stylistic quality. Consequently the poems and stories featured a mixture of rhetorical figures and tropes, and no conclusions about the effect of single features (metaphors, sound figures, syntactic figures etc.) can be made. Also the reported correlations of reading speed and affect have to be treated with caution, because not all foregrounding techniques might have the same effect on processing difficulty. Whereas novel metaphors probably slow down comprehension, sentence processing is facilitated by syntactic parallelistic structures (Sturt et al., 2010). Experiments on isolated rhetorical figures inform about the processing characteristics of specific foregrounding techniques. Lea et al. (2008) reported enhanced memory for words within alliterations in poems. In an interdisciplinary research across psychology and stylistics, Emmott et al. (2006) could show how the foregrounding technique of using text fragments and short sentences is capable of guiding attention towards specific content.

The alternative technique of *derhetorizing* was successfully applied in the studies of Van Peer (1990) and Van Peer et al. (2007). He investigated effects of meter by presenting readers with a metrical and a non-metrical version of a poem. By re-arranging and re-writing the originally metrical poem into a non-metrical version, the rhetorical quality of meter was removed while at the same time rhyme and alliterations were kept intact. In the study of Van Peer et al. (2007) even six versions of a line of poetry with ascending degree of foregrounding were created. This technique, which will be referred to as *derhetorizing* throughout this dis-

sertation, gives experimental control over the rhetorical figure of interest. While also the other direction of manipulation is possible (inserting extra rhetorical figures and tropes in a text of low rhetorical quality), it is usually easier to deliberately lower the quality of a text or poem than to improve it. In the experiment by Van Peer (1990) readers reported significantly enhanced esthetic pleasure and showed more precise memory for the metrical poem. Given that *derhetorizing* is performed cautionsly and consciously without affecting semantics or other text properties, *derhetorizing* potentially allows for causal interpretations, contrary to the correlative approach in the studies by Miall (2008); Miall and Kuiken (1994). Another example of successful *derhetorizing* is the work of McGlone and Tofighbakhsh (2000) who showed that participants have more trust in rhyming than non-rhyming versions of aphorisms.

Summarizing the available literature on foregrounding does not result in a consistent effect of foregrounding on affective and esthetic processes in reading. The studies by Miall and Kuiken (1994) and Van Peer (1986); Van Peer et al. (2007) consistently demonstrate hindered processing and more intense affect for reading foregrounded text. Referring to the Structuralist view, these results suggest that slowed down processing intesifies the aesthetic pleasure. In contrast, results from visual esthetics (Belke et al., 2010; Kuchinke et al., 2009; Reber et al., 1998; Tinio et al., 2011) implicate that people prefer easy to process stimuli. One of the earliest publications on the mere-exposure effect (Zajonc, 1968) reported positive correlations with word frequency and affective connotiation. Most likely, there is no simple linear relationship between the degree of foregrounding and positive esthetic evaluation. Apparently under certain conditions, which are yet to be defined, people rather prefer easy processing, whereas in other cases people prefer object that are difficult to process.

Candidate variables for the modulation of this process can be found on the level of person, text, and context. Person variables might be cultural background and level of expertise. Zyngier et al. (2007) found predicted foregrounding effects only for a group of Dutch participants, but not for Brazilian and Egyptian, thus raising the question of generalizability of foregrounding effects across people from different cultural backgrounds. The level of expertise has been shown to influence esthetic processing in visual art (Hekkert and VanWieringen, 1996; Leder et al., 2006, 2012) and might also determine which level of foregrounding readers appreciate. Expertise could also be influenced through repeated readings in an experiment. Hakemulder (2004) reported that after a second reading his participants enjoyed foregrounded literary texts more than texts with less rhetorical complexity. Carbon and Leder (2005) have shown that repeated evaluation of high and low innovative car interiors captures dynamic effects of attractiveness. Likewise, different effects of repeated readings for high and low foregrounded text could be expected. Finally, context variables such as the genre of the text

influeces, whether readers expect and prefer textual opacity or clarity (Galak and Nelson, 2011). In an experiment with not optimally controlled stimulus material, Hanauer (1998) discovered that poetry is read slower and involves higher levels of surface information recall than encyclopedic texts, so when reading poetry readers might expect and enjoy a level of textual opacity that they would not accept in a newspaper article. A comparable effect can be found in face processing: while people generally find prototypical, average faces highly attractive (Langlois and Roggman, 1990) because they are easy and fast to process, one of the most famous female portraits in art, the Mona Lisa, is adored exactly because nobody is able to determine her expression (Bohrn et al., 2010).

In the experiments presented in the following chapters, person and context variables were held constant. Participants were recruited from student population without special education in literature or poetry. Instead, the focus of this dissertation is on foregrounding on the text level by using the paradigms of derhetorization (chapter 5) and defamiliarization (chapter 3). In the following the main hypothesis concerning foregrounding effects will be elucidated.

1.7. Conceptualization of the empirical part of the thesis

The aim of this thesis was to use experimental techniques and neuroscientific methods to provide measures of how readers react to rhetorical foregrounding. From the model of literary reading sketched in section 1.5 the following hypotheses were derived:

1. Text foregrounded with rhetorical figures or tropes is read differently than text consisting of literal, predictable words. The effects of foregrounding should become evident both in the subjective experience of readers as well as in correlates of their neuronal processing.

2. At the neuronal level, reading foregrounded text involves more RH networks, whereas reading background text basically relies on the LH reading network.

3. Readers experience more intense emotional states when reading foregrounded text than when reading background text. Qualitatively these emotions are esthetic emotions such as interest, pleasure, being moved, or a feeling of beauty.

When designing experiments to test these hypotheses, the first raising challenge was the selection and the construction of stimuli. A typical problem in experiments on esthetics is finding the balance between ecological validity of stimuli (maximized in e.g. original poems or pieces of literature) and the limitations and requirements of experimental research such as a sufficient number of items, matched on a number of relevant control parameters. With only a handful of experiments on effects of rhetorical language available (Lea et al., 2008; McGlone and Tofighbakhsh, 2000; Miall and Kuiken, 1994), no validated standard procedures could be applied. Although there are countless rhetorical figures and tropes, experiments in pycholinguistics focus nearly exclusively on metaphors and idioms. The central topic of these studies is regularly the cold cognitive processing of figurativeness. Affective characteristics of figurative language and foregrounding effects are hardly ever mentioned. Because of the prominent question of lateralization in metaphor and idiom research, a meta-analysis on figurative language processing was considered suitable for examining the lateralization hypothesis of the model of literary reading. Figurative language was considered to be a type of *defamiliarization* as suggested by Grice (1975). In the Gricean view, figurative language is per se more difficult to process than literal language, because figurative language violates the "maxim of truthfulness". Grice assumed an implicit contract between the speaker/writer and the listener/reader based on which the reader/listener assumes that the speaker/writer is trying to communicate in an understandable, direct, literal way. Because unconventional figurative language, such a novel metaphor, is a way to express a literal thought in an unfamilar, non-obvious (and somtimes literally wrong) way, it can be considered *defamiliarized*.

With the support and valuable considerations of experts in the field of poetics and rhetorics, who were also affiliated with the cluster "Languages of Emotion", stimuli for two experiments could be constructed from scratch. In the fMRI experiment (see chapter 3) a type of semantic foregrounding was accomplished through *defamiliarization*. In contrast to the example of figurative speech given above, the term *defamiliarization* was taken literally for the construction of these stimuli: By substitution of single words, variants of highly familiar German proverbs were constructed. Because extensive pretesting ensured the familiarity of the original proverbs and affirmed that the variants were recognized as such, the resulting proverb variants were close enough to the original to activate the familiar "background" but were sufficiantly altered to elicit a moment of surprise because of the unexpected foregrounded word. Proverbs turned out to be suitable for creating this effect, because unlike idioms or metaphors they are fixed expressions and many people know them in the exact same wording. With this pool of stimuli effects of *defamiliarization* could be investigated systematically. In the second experiment two non-semantic variables were chosen, namely rhyme and meter. Stimuli were constructed using by *derhetorizing* two-lined

couplets by Wilhelm Busch, which all featured rhyme and meter. *Derhetorizing* was accomplished by creating versions of the couplets without rhyme and meter. Through careful changes in word order and wording and in close interdisciplinary collaboration with experts from the field of literary studies these foregrounding elements were eliminated with only minimal changes on the semantics. The resulting stimuli varied in rhyme and meter in a 2x2 design and could be used for a series of rating studies and experiments.

The technique of *derhetorizing* proved as a useful paradigm for investigating rhetorical effects. An advantage in terms of ecological validity is that original literary material can be used while securing experimental control over the amount of rhetorical figures and tropes. By performing cautios changes in the text material, specific rhetorical figures can be eliminated while controlling for e.g. length, word frequency, semantics, syntax, and other rhetorical figures (Van Peer, 1990). Admittedly, the process of constructing and validating such items is not only time-consuming, but also requires expertise on psycholinguistics and rhetorics. In the cluster "Languages of Emotion" access to such expertise was available through a number of colleagues from rhetoric and literary criticism. A potential pitfal is that such a pool of stimuli is highly specific and effects found with it might not be easy to replicate with other sets of stimuli.

Also, methodological choices had to be made. The model of literary reading makes predictions about the relative lateralization of foreground- and background reading. Therefore, fMRI was better suited than EEG, because fMRI has superior local resolution. As a consequence, this dissertation is not informative about potential differences in the time-course of background and foreground reading. This relevant question has to be the topic of future studies. The low temporal resolution of fMRI was, considered to be a potential advantage when reading whole sentences, because people read at different speed. In experiments with auditive presentation, the timing of sensory input is externally controlled and constant for all participants. In contrast, a central problem for all reading experiments with other than single-word presentation is the lack of control over the timing of the sensory input. The experimenter can not determine the exact point in time at which participants read a specific word, unless eye-movements are recorded. For an EEG design one would have had to deal with the high temporal sensitivity of EEG and would have had e.g. to analyze fixation related potentials, which is possible but technically very complex

Choices concerning the tasks were made with the intention to minimize interference with natural reading. A problem of many experiments on the neural correlates of esthetic processing are explicit esthetic judgment tasks during the fMRI experiment. When participants perform a task related to esthetic evaluation, a mode of esthetic processing might be artificially introduced by the task

demands. In the fMRI experiment presented in chapter 3 and 4, items were followed by a semantic categorization task. Participants had to decide if the sentences they had just read fit into a semantic category, such as "health". Because participants did not know the category at the time of reading, it is unlikely they were already making specific decisions while reading. Still the task motivated them to read and interpret the sentences. More importantly, the instructions did not force participants into a mode of esthetic perception. In all experiments, subjective experience was accessed by rating scales. In the fMRI experiment, participants rated beauty and familiarity of the items after the scan, in the series of experiments presented in chapter 5, participants judged the items on scales of succinctness, funniness, valence, arousal, intensity, and intelligibility.

In the course of the next chapters four empirical studies on affective and esthetic processes of reading will be presented. First, I will give a summary on the content of the following chapters:

Chapter 2: Looking at the brains behind figurative language: A quantitative meta-analysis on metaphor, idiom, and irony processing

The main question of this chapter will be: What are the general neural correlates of figurative language processing? To start with, the neuroimaging literature will be analyzed and reviewed to analyze if there is evidence for common and/or distinct networks involved in figurative and literal language processing. More specifically the issue of right hemisphere involvement in figurative language processing will be addressed.

In a quantitative, coordinate-based meta-analysis data from 354 participants were combined across 22 fMRI studies and one PET study on metaphor, idiom, sarcasm and irony processing. Studies that reported peak activations in standard space contrasting figurative vs. literal language processing at whole brain level in healthy adults were included. To identify common and distinct neural correlates of different types of figurative language, subgroup comparisons between experiments on metaphors, idioms, and irony/sarcasm were performed. The meta- analysis revealed a consistent set of areas involved in processing figurative language: The left and right IFG, large parts of the left temporal lobe, the bilateral medFG and an area around the left amygdala emerged for figurative language processing across studies. Conditions requiring exclusively literal language processing did not activate any selective regions in most of the studies, but if so they activated parts of the "mentalizing network" such as the cuneus/precuneus, right MFG and the right IPL. No general RH advantage for metaphor processing could be found. In contrast, significant activation clusters for metaphor conditions were mostly lateralized to the LH while exclusively literal conditions also activated the RH. Idiom and metaphor processing shared activations in left fron-

totemporal regions. Irony and sarcasm processing was correlated with activations in midline structures such as the medFG, ACC, cuneus, and precuneus. The results are in line with theories proposing that more analytic, semantic processes are involved in metaphor comprehension, whereas irony and sarcasm comprehension require greater abilities of theory of mind. In this chapter the differences and commonalities between metaphors, idioms, and irony sarcasm will be discussed both in terms of a theoretical distinction and in terms of shared and distinct brain areas involved in processing these different types of figurative language.

Chapter 3: Old-proverbs in New Skins - an fMRI Study on Defamiliarization

This chapter will elaborate on the technique of *defamiliarization* and will focus on the questions: what are the specific effects of familiarity and *defamiliarization* on affective and esthetic evaluations in the process of reading? According to the hedonic fluency hypothesis (Reber et al., 1998), easy (fluent) to process stimuli will have a more positive connotation than stimuli requiring more processing effort. Are familiar expressions preferred over unfamiliar and defamiliarized expressions? Or are defamiliarized expressions preferred because they are more interesting? An fMRI experiment will be presented investigating, how the processing of familiar and defamiliarized proverbs is coded on a neuronal level. Is *defamiliarization* associated with enhanced affective processing?

Familiarity and *defamiliarization* are two factors known to influence the esthetic evaluation of artworks, design objects, and music. In an fMRI experiment the neural correlates of processing (a) familiar German proverbs, (b) unfamiliar proverbs, (c) twisted variations which altered the concept of the original proverb (proverb variants), (d) variations with incorrect wording but the same concept as the original proverb (proverb substitutions), and (e) non-rhetorical sentences were compared. The aim of the study was to investigate how processing fluency and *defamiliarization* contribute to affective and esthetic processes during reading. The experiment was designed as an event-related fMRI experiment with 26 participants. Consistent with the coarse semantic coding theory, proverb familiarity affected lateralization: relative to non-rhetorical sentences highly familiar proverbs activated the left parahippocampal gyrus, whereas unfamiliar proverbs activated an extensive network, covering bilateral frontotemporal cortex. These findings relate to the laterality debate that is also subject of chapter 2. Not all types of semantic foregrounding are processed equally: While proverb-variants triggered a process of affective evaluation, proverb-substitutions recruited the fronto-temporal regions associated with attention and error-detection. These results indicate that *defamiliarization* is a proper tool to guide attention, however, only *defamiliarization* of the core concept of a familiar expression (in case of proverbs this would be a moral or social norm) triggers affective re-

evaluation. Despite affective processing being enhanced for proverb-variants, familiar proverbs received the highest beauty ratings, supporting the hedonic fluency theory. The results will be discussed within the framework of the model of literary reading (Jacobs, 2011).

Chapter 4: When we like what we know: A parametric correlation analysis of familiarity and beauty

In this chapter a re-analysis of the experiment from chapter 3 will be presented. In the simple contrast analyses no effects in the reward circuits had been found. But this might have been due to larger variance in the type of stimuli individual participants found esthetically pleasing. Thus, this chapter will focus on subjective components of beauty evaluation to find out if spontaneous esthetic evaluation had been going on during reading. How do the neural correlates of esthetic evaluations of text relate to results from other domains of esthetic experience (e.g. artworks, music, design, faces)? Are there hints towards modality specific components? In the fMRI experiment participants read a number of proverbs without explicitly evaluating them. After the scan they rated each item for familiarity and beauty. These individual ratings were correlated with the functional data to investigate the neural correlates of implicit esthetic judgments. Clusters in which BOLD activity was correlated with individual post-scan beauty ratings were identified. This indicates that some spontaneous esthetic evaluation takes place during reading, even if not required for the task. Positive correlations were found in the caudate nucleus and in medial prefrontal cortex, likely reflecting the rewarding nature of esthetically pleasing sentences. On the contrary, negative correlations were observed in the left frontotemporal reading network. Midline structures and bilateral temporo-parietal regions correlated positively with familiarity, suggesting a shift from the task-network towards the default network with increasing familiarity.

Chapter 5: Sounds funny? - Humor effects of phonological and prosodic figures of speech

The preceding chapters focused on the effect of semantic rhetorical figures and tropes on affective processing of language. But how do phonological and prosodic figures influence the emotional response of the reader? This question will be explored using the example of humorous rhymes. Popular theories of humor focus on semantic scripts or semantic incongruity that might elicit a humorous reaction. But can sound figures also contribute to the perceived funniness of a poem? These questions will be addressed in an experiment with verses by the famous German author Wilhelm Busch in which meter and rhyme were systematically manipulated.

Most popular theories of humor explain humor in terms of social and/or semantic relationships. The incongruity-resolution theory (Ritchie, 1999), for instance, describes humor as the reaction towards a perceived incongruity that suddenly can be resolved. The General Theory of Verbal Humor (Attardo, 1997; Attardo and Raskin, 1991) is based upon a semantic model that allows for a description of certain semantic scripts that are highly likely to elicit a humor reaction. The role of non-semantic figures (e.g. phonological and prosodic figures, such as rhyme or alliteration) in the elicitation of humorous emotions has not been investigated yet with experimental methods. However, scholars of literature have long discussed the emotion-boosting function of rhyme and meter e.g. in the works of famous German poet and humorist Wilhelm Busch (Ueding, 1986). This chapter will introduce the reader to an experiment in which 60 two-line verses by W. Busch were systematically derhetorized using an innovative technique of manipulating original poetic stimulus material in order to fulfill experimental requirements. Sixty two-lined verses were chosen, that all featured the characteristic end-rhyme as well as an alternating iambic meter, as it is typical for W. Busch and other German poets. These verses where then rewritten and manipulated in a way to create three novel versions complementing the original verses; one featuring only rhyme, one featuring only meter and one "fully derhetorized" version without rhyme and meter. Care was taken not to change the semantic content and to create the novel versions mainly through rearrangement or by replacing single words by synonyms. This chapter will focus on a series of experiments in which the original and novel versions were read self-paced and were afterwards rated on several dimensions. The results indicate that both rhyme and meter contribute to the perceived funniness of a verse. Rhyme additionally raises the valence and intensity of an emotional reaction to the verse. Furthermore, rhyme was found to be an influential factor on the error rates in a memory experiment conducted with all different versions. Results will be discussed within the framework of the hedonic fluency theory and implications for theories of humor will be made.

Chapter 6: General Discussion and Outlook

In the final chapter, the results from the meta-analysis, the fMRI-experiment and the behavioral experiments will be recapitulated and conclusions on processing characteristics of foregrounding in short sentences and verses will be made. Foregrounding effects on the levels of subjective experience, reading times, and neuronal correlates will be discussed. Answers to the central hypothesis of enhanced affective responses towards foregrounding and to the question of RH lateralization of foreground reading will be given. I will offer possible follow-up studies to answer remaining open questions and provide an outlook for future directions of foregrounding research.

2 Looking at the brains behind figurative language

A quantitative meta-analysis on metaphor, idiom, and irony processing [1]

[1] This chapter was published as Bohrn, I. C., Altmann, U., and Jacobs, A. M. (2012). Looking at the brains behind figurative language: A quantitative meta-analysis on metaphor, idiom, and irony processing. *Neuropsychologia, 50* (11), 2669-2683. The document is accessible online: http://dx.doi.org/10.1016/j.neuropsychologia.2012.07.021

3 Old proverbs in new skins

An fMRI study on defamiliarization [1]

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4 When we like what we know

A parametric correlation analysis of familiarity and beauty [1]

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5. Sounds funny? - Humor effects of phonological and prosodic figures of speech

5.1. Introduction

Humor[1] is a uniquely human faculty. It is mostly communicated through language (Bergson, 1911), but how exactly humor is coded in language is an unsolved question. Despite of a variety of models of humor elicitation, most psycholinguistic theories agree that humor is typically elicited by resolution of incongruity between levels of semantic meaning. This process is described in incongruity-resolution theories (Koestler, 1964; Suls, 1976), the Comprehension-Elaboration Theory (Wyer and Collins, 1992) and the General Theory of Verbal Humor (Attardo and Raskin, 1991) in the self-rewarding decoding of surprising connections between disparate elements (Cicero, De oratore, II.216-290). If humor were solely coded semantically, then why do (not only) children easily laugh about rather senseless verses that rhyme or show other features of being subject to some repetitive phonological extra regularites that have an air of (misplaced) "mechanical" patterning out of synch with expectations regarding a typical meaningful sentence? Freud (1960) emphasized that incongruity does not only have to be based on a joke's semantic content. Alternatively or additionally, the "technique" of a joke can rely on the choice of linguistic form. To what extent formal, stylistic features influence the processing of a joke, however, has not yet been explored empirically. Experiments typically focus on logical operations or narrative structures (Bartolo et al., 2006; Coulson and Kutas, 2001). The psychological effects of specific stylistic features on language comprehension are hardly investigated, although it has been shown that people find rhyming aphorisms more truthful than non-rhyming aphorisms (McGlone and Tofighbakhsh, 2000) and that alliterations can enhance the memorability of words in a poem (Lea et al., 2008). In an adaptation of Bergson's philosophy of laughter 1911, which emphasized the comical effects of "mechanization", we hypothesized that stylistic properties

[1] Adapted version of a manuscript in preperation for submission to Psychological Science

affect the cognitive and affective sentence processing by imposing conspicuous, apparently senseless, and higly repetitive "mechanical" regularities on phonological sentence structure. Here we demonstrate for the first time empirically how formal features, which infuse language with artificial mechanism (by a special use of meter and rhyme) can enhance the humorous effect of sentences.

5.2. Method

We extracted 60 unfamiliar two-lined couplets from the work of the popular German humoristic poet Wilhelm Busch (1832-1908), whose narratives in rhyme and meter are published in several languages, including English. In the original version all couplets are rhymed and written in iambic meter (e.g. "Es ist ein Brauch von alters her: / Wer Sorgen hat, hat auch Likör!" = "From ancient times it has been true: / he who has cares has liquor too"; transl. Arndt,1982. These couplets are not jokes in any formal definition of this term, because they lack a narrative structure (cf. Attardo and Raskin, 1991) but humor extends far beyond telling and appreciating jokes. For a taxonomy of humor, wit, and jokes as well as for a good working definition of their interrelations see Long and Graesser (1988).

Through careful minimal changes in word order and by replacing words through synonyms in the first lines of the couplets, we created item quadruples that varied in a 2 (rhyme/non-rhyme) x 2 (meter/non-meter) design. In each experiment participants silently read each couplet in one version in random order. Versions were balanced across participants in a Latin Square fashion. The couplets were presented line by line and participants moved self-paced through the experiment by button-press. Between items, participants rated the preceding couplet on a 7-point Likert scale. In Experiment 1, 40 participants (20 female) rated the couplets on funniness and reading times were recorded. In Experiment 2, 28 participants (14 female) rated rhetorical succinctness. In Experiment 3, 32 participants (16 female) rated valence, arousal, and affective intensity using the SAM scales (Bradley and Lang, 1994). In Experiment 4, 36 participants (18 female) first rated intelligibility and afterwards performed an unannounced old-new memory-task in which couplets were presented in the same or different version as during the prior rating task. For data analysis, repeated-measurements ANOVAs were calculated, treating items as random factors. Memory effects were analyzed based on signal detection theory by calculating accuracy

$$d' = z(hitrate) - z(falsealarmrate)$$

and response bias:

$$c = -0.5\{z(hitrate) + z(falsealarmrate)\}$$

5.3. Results and Discussion

The results of the ratings from Experiment 1-4 are presented in figure 5.1. Here we show for the first time both affective and cognitive effects of rhyme and meter on sentence processing. As predicted, rhyme and meter enhanced funniness ratings, confirming that purely phonological and prosodic properties of a sentence can boost the quality of a joke (main effect for rhyme: $F(59,1) = 258.81, p < .001, \eta^2 = .81$; main effect for meter: $F(59,1) = 6.98, p < .01, \eta^2 = .11$). In general the overall affective response in terms of arousal ($F(59,1) = 12.61, p < .001, \eta^2 = .18$), valence ($F(59,1) = 20.99, p < .001, \eta^2 = .26$), and intensity ($F(59,1) = 5.11, p < .05, \eta^2 = .08$), was higher towards rhyming than non-rhyming couplets (but unaffected by meter). Both poetic features increased the processing fluency of the verses: non-metered versions elicited slower reading times on the first line (the only line that was demetrizised; $F(59,1) = 4.38, p < .05, \eta^2 = .07$), while in non-rhyming versions the second line was read slower (at the end of which the rhyme would be expected; $F(59,1) = 10.61, p < .002, \eta^2 = .15$). The rhyming couplets were also rated as being more succinct ($F(59,1) = 124.74, p < .001, \eta^2 = .68$) and intelligible ($F(59,1) = 37.89, p < .001, \eta^2 = .39$) than the non-rhyming versions. There were no significant interaction effects, except for an interaction of rhyme and meter on valence ($F(59,1) = 4.39, p < .05, \eta^2 = .07$). In sum, these results demonstrate higher processing fluency for the metered and rhyming conditions over non-metered and non-rhyming conditions even during silent self paced reading. The couplets featuring meter and rhyme were also remembered better than the versions without meter and rhyme. Recognition accuracy was significantly enhanced by rhyme ($F(35,1) = 4.85, p < .05, \eta^2 = .12$) but with only a tendency for meter ($F(35,1) = 3.4, p = .07, \eta^2 = .09$), whereas response bias was unaffected by meter and rhyme. This means that when presented with a rhyming version, participants knew with higher accuracy than for non-rhyming versions whether they had read the exact same verse before or not.

In sum, rhyme and meter had positive effects on funniness, confirming that formal properties can enhance the quality of a joke. (Especially rhyme intensified the overall affective experience of the couplets.) However, while it is noteworthy that both stylistic features affected the funniness dimension, we do not claim that certain rhyme schemes or types of meter always have an inherent humorous effect. Even the versions without rhyme or meter received ratings in the mid-

range of the funniness scale. To create effects of incongruity, Wilhelm Busch used rhyme and meter in specific ways: While the meter is typical for traditional words of wisdom, the message wrapped in this form is not very sophisticated. Banal content is conveyed in an elaborate form. A manifest use of meter that poeticizes popular language and a forced application of rhyme that joins disparate elements across verses have comical effects They combine "mechanization" and surprise in original ways and provide the readers the pleasures of decoding incongruities. Our results highlight the power of poetic and stylistic features to enhance the affective quality of jokes and, more generally, in sentence processing. We here add an empirical proof that some uses of meter and rhyme can serve as a genuine source of linguistic funniness and humor.

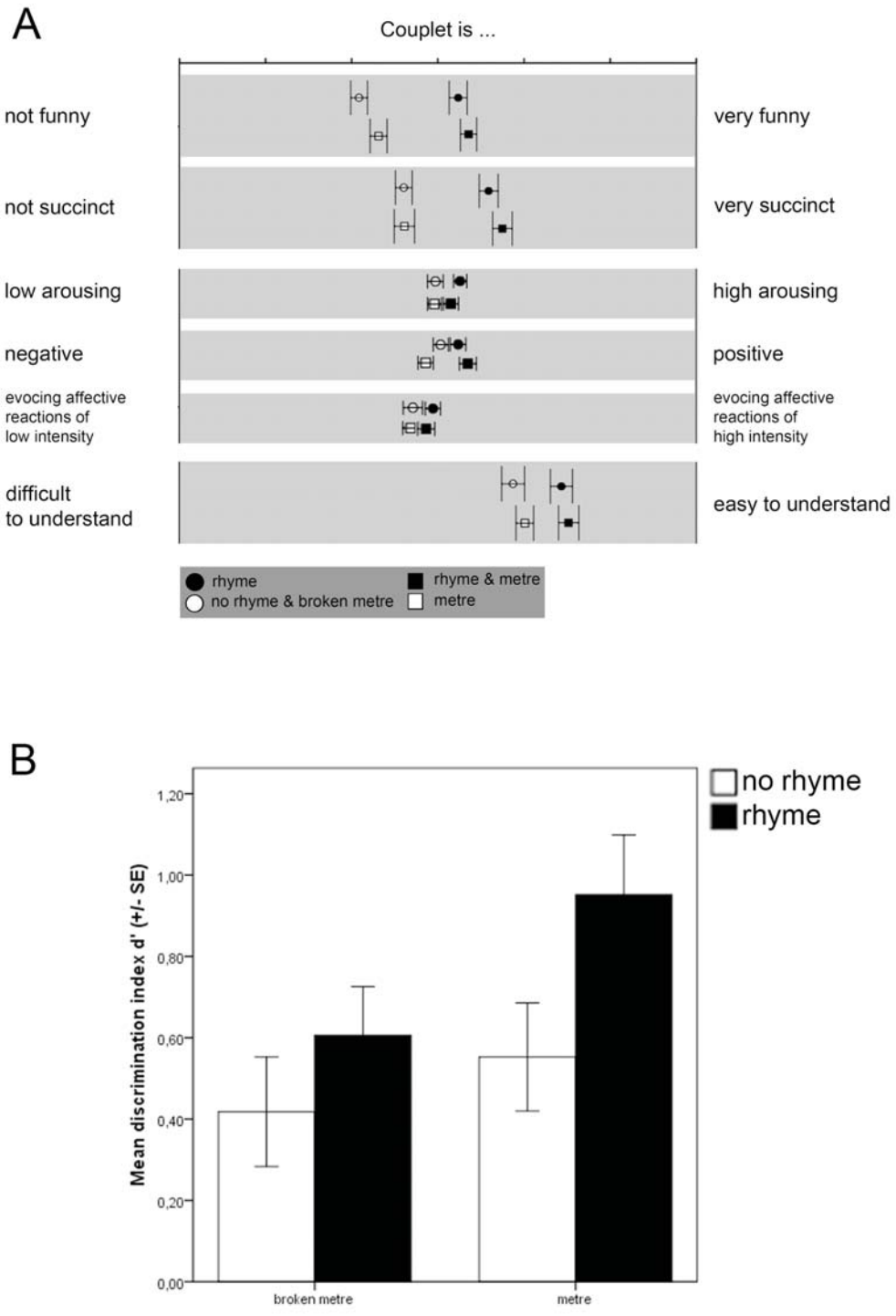

Figure 5.1.: (A) Rating data from Experiment 1-4; Means and Standard Errors; (B) Recognition accuracy in Experiment 4

6. General Discussion and Outlook

For this dissertation project two experiments and a meta-analysis were conducted. I investigated how stylistic characteristics of short sentences and verses influence affective and esthetic responses in readers. The central hypothesis behind the experiments is that written sentences foregrounded with rhetorical figures and tropes are processed with enhanced affective intensity. In a multimethodological approach I first investigated foregrounding effects on the level of subjective experience through affect-related rating scales and later validated these results by linking them to differences in brain activity. The parts of the brain involved in language processing are relatively well understood with a number of regions in the mainly LH frontal and temporal cortex being specialized for different sub-processes (see Price, 2012 for an extensive review).

6.1. Foreground- vs. Background-Reading

In all studies effects of foregrounding techniques on reading were observed. The meta-analysis identified robust differences in processing figurative and literal language. Processing figurative language relied on activation in the bilateral IFG, left temporal cortex, medial prefrontal cortex and the left amygdala. The results from the subgroup analyses already indicate processing differences between various types of figurative language. Processing irony, for example, was more likely to involve the medial frontal cortex than processing metaphors or idioms. This finding reflects the strong need for mentalizing when understanding irony. Although only based on small numbers of experiments, the results from the subgoup-analyses raised expectations for finding processing differences between different types of foregrounding in subsequent studies. In the fMRI experiment on proverb-processing, foregrounding was not achieved by manipulating figurativeness, but by creating defamiliarization through single-word substitutions in familiar German proverbs. The results support to the conclusions from the metastudy because effects of defamiliarization were also located in the IFG. Thus the bilateral IFG are likely candidate regions for general effects of foregrounding.

Activation of the occipital gyri might be related to a specific visual salience of the unexpected substituted word. Again, comparing different types of semantic foregrounding resulted in different activation patterns. In addition to an unspecific response to foregrounding in the IFG, different styles of foregrounding demand distinct processing components. The data from the final experiment on Busch-verses convincingly demonstrate enhanced affective processing of verses foregrounded through rhyme and meter. This finding replicates and extends earlier findigs by Van Peer (1990). Across all experiments stylistic qualities of sentences modulated the reading process in silent reading. Thus, rhetorical figures are not only to be considered as potential confound variables in experiments on sentence and text-processing, but, more importantly, they call for further investigation. The data confirm a central hypothesis of the model of literary reading (Jacobs, 2011) that stylistic text qualities influence the affective processing of text. Sentences that were put into "foreground" through semantic or phonological figures were processed with more attention and affective involvement than more conventional sentences.

6.2. On lateralization

The model of literary reading (Jacobs, 2011) makes several predictions about the characteristics of foreground- and background reading on the level of subjective experience, behavior, affective, and cognitive processing. Concering neuroanatomical lateralization, a main prediction of the model was a lateralization towards the RH when reading reading foregrounded text. Reading background text was supposed to rely mainly on the LH reading network. This prediction was based on the coarse-semantic-coding theory (Jung-Beeman, 2005), according to which the RH and LH differ neuroanatomically, with the RH being better suited to activate coarse semantic fields when processing words. Accordingly, the RH processing style is more adequate when processing metaphors and other types of language that require creative interpretations. This hypothesis is related to the popular and controversial idea of the RH being the "creative hemisphere", contrary to the more "analytic" LH (Bogen, 1969). The coarse-semantic-coding theory and the related Graded Saliency hypothesis (Giora and Rachel, 1997; Giora et al., 2000) are referred to in the majority of psycholinguistic experiments on figurative language. However, in a recent review Kasparian (2013) describes substantial variation in task, use of stimuli and operational definitions of figurativeness that prevent a final conclusion about the hemispheric lateralization of figurative language processing. The quantitive meta-analysis on figurative language processing did not support the theory of hemispheric lateralization. Except for a small cluster in the right IFG, the figurative-language network was clearly dominant to the LH. In the subgroup-comparisons some structures in the

right temporal lobe emerged, but activation in the LH was more reliable. Contrary to the prediction of the model of literary reading, no general RH advantage for foregrounded language was observed. But in line with Cardillo et al. (2012), RH contribution was related to the degree of sentence-novelty. Resulting from the meta-analysis, activation in the right ACC and right insula/IFG is rather found in experiments with novel than conventional metaphors. This confirms to larger RH activation for processing unfamiliar than familiar proverbs. However, in both the metastudy and the proverbs-experiment, left frontotemporal regions were coactivated when processing foregrounded text. In fact, effect sizes were even larger in the LH. In sum, these data call for revised verion of the model of literary reading regarding the neuroanatomical localization of reading foregrounded language. The bilateral IFG were involved in processing figurative language, as well as in all *defamiliarized* proverb conditions, probably indicating enhanced working memory load (Addis and McAndrews, 2006; Downar et al., 2002). Thus, instead of assuming a general shift of activation towards the RH, the current data implicate that foregrounded text has high salience and enhanced working memory load.

Depending on the type of foregrounding, additional regions become involved as different types of foregrounding demand for different sub-processes of language comprehension. For instance, encountering a novel metaphor requires the integration of two unrelated semantic concepts and thus rather relies on parts of the left temporal lobe that are known to be involved in assessing the semantic field of words, such as the STS, MTG, and TPJ (Price, 2012). To detect an ironic statement, a reader has to infere about the intentions of the speaker/writer. Such mentalizing recruits the medPFC more other types of figurative language. In the case of defamiliarization through word substitution, there is a very specific mismatch between the expected and the present word, thus making the unexpected word visually salient. This salience is reflected in the activation of the visual cortex when reading defamiliarized proverbs (see chapter 3). Similar activation patterns are expected for other foregrounding techniques with strong visual components such as line breaks, changes in font type, or conspicuous repetition figures (e.g. alliterations, anaphors). In contrast, predominantly phonological foregrounding techniques (e.g. rhyme, meter, onomatopoeia) are expected to activate the auditory cortex and adjacent regions in the STG (Booth et al., 2002; Burton et al., 2005; Hashimoto et al., 2006). To test this hypothesis, the Busch verses have to be read in the MRI-scanner in a planned follow-up experiment.

6.3. Foregrounding and emotional responses

The three studies all demonstrate effects of foregrounding. These effects do not converge into a uniform pattern, neither on the neuronal level nor in terms of rating responses. While differences in the results of three studies with variations in analysis, stimuli and task have to be interpreted tentatively, they speak in favor of more than one single way of foreground-reading. The effects of foregrounding techniques on reading seem to depend on the type of foregrounding. Concerning the hypothesis of more intense emotional experience when reading foregrounded text, neuronal data are supportive for certain types of foregrounding. Enhanced amygdala activation when reading figurative language hints towards higher emotional significance of figurative language. This fits well to the implicit assumption of metaphors and idioms being frequently used in literature and poetry to intensify the emotional experience and to animate a text. As a restriction, the meta-analysis did only cover the neuronal level and is not informative regarding subjective experiences. If the participants in the source experiments really experienced more intense emotions is not reported in the papers. In most psycholinguistic experiments the subjective experience when reading figurative language was not even assessed. The hints towards more intense affective processing in figurative language provided by the meta-analysis hopefully inspires psychologists, and psycholinguists to investigate and accounted for affective responses to figurative language in future studies.

In the proverbs-experiment, data on the neuronal level as well as reader responses were collected. They suggest enhanced affective processing only for some type of foregrounding. A conjunction analysis revealed signs of raised attention towards the substitutes word for both types of defamiliarization. But only substitutions affecting the general meaning of the sentence (e.g. All sins lead to Rome) but not substitutions affecting the wording (e.g. All streets lead to Rome) activated affect-related brain areas, namely the OFC and medPFC. Foregrounding on a semantic or conceptual level probably elicited affective evaluations, because the conceptual mismatch challenges content schemata and makes substantial reinterpretation and re-evaluation likely.

In contrast to prior findings from empirical esthetics (Miall and Kuiken, 1994; Van Peer, 1986; Van Peer et al., 2007), not all rating results pointed towards more intense affective responses on foregrounded language. The proverbs-experiment resulted in the somehow contradictory finding of neuronal data suggesting more affective salience for foregrounded proverb-variants, while participants speaking in favor of the original, familiar proverbs. Unpublished results from a liking- and a esthetic appreciation-scale point into the same direction. In the experiment on Busch verses, in contrast, the versions foregrounded with me-

ter and rhyme were preferred and were associated with more intense emotional responses.

Let us focus on the rating results first. Participants did not always enjoy the most foregrounded sentences, but in both experiments participants preferred the easy and fast to be processed versions: Ratings from the proverbs-experiment selected original familiar proverbs as being the most beautiful condition. Across all conditions post-test ratings of beauty and familiarity showed a significant positive correlation of $\tau = .435$. Although no reaction or response times were obtained, the brain data implicate reduced engagement of the reading network for familiar proverbs relative to literal sentences. Most likely, familiar proverbs were processed with a minimum of cognitive effort. This result is in line with the hedonic fluency hypothesis (Reber et al., 1998), and so are the results from the Busch-experiment. The rhymed and metric verses were read faster than the non-rhymed and non-metric variants. Stimuli were not rated for beauty (as this was an odd scale to rate humorous verses on), but rhyming and metrical versions received higher rankings on funniness, poetic succinctness, positive valence, arousal, and affective intensity than other conditions.

Familiarity and cognitive fluency effects provide viable explanations for some of the results but, importantly, they do not provide the whole picture. The hedonic quality of familiar proverbs was big enough to single them out on the beauty scale. However, the corresponding effects of brain activity did not show up in reward-related areas (e.g. nucleus accumbens) but in the parahippocampal gyrus, thus rather suggesting a memory effect. Apart from this activation, familiar proverbs recruited the same brain areas as inconspicuous literal sentences. With regard to the neural signature of fluency effects, the positive impact of cognitive fluency is rather subtle and not driven by activation of the reward system. In an fMRI-experiment on facial attractiveness Zebrowitz and Zhang (2012) have recently come up with a similar conclusion; familiarization rather reduced negative feelings instead of raising positive ones. Noteworthy is the finding of activation in the nucleus accumbens with the parametric analysis in chapter 4, becuse it shows reward related beauty effects irrespective of familiarity. Apart from the general beauty-familiarity correaltion, beauty evaluation has individual components and to describe their subjective nature, further experiments are needed.

Two conclusions on foregrounding can be drawn:

1. Foregrounding techniques serve different purposes. The Formalists focused on the aspect of alienating a text (Shklovsky, 1998), of slowing dwon processing to intensify esthetic pleasure. Indeed, certain rhetoric tropes such as oxymoron or novel metaphors probably complicate text comprehension. At the same time, other rhetoric figures potentially increase the speed of processing, because they repeate and structure information (e.g. anaphors). Proverbs as such, when used in a speech or text and not in isolation, can summarize complicated matters and serve moral advice in a comfortable and subtle form. Therefore, the mere number of foregrounding features does not allow for predictions concerning processing effort unless the type of foregrounding is analyzed as well.

2. Genre-expectations potentially influence, whether cognitive fluency or linguistic complexity are better appreciated. In line with the Formalists' hypothesis, Miall and Kuiken (1994) reported more intense affective reactions towards those passages of a text that took participants longer to read because of the density of foregrounding elements. In the genre of literary texts a certain amount of processing difficulty and opaqueness might be expected and is probably interpreted by readers as a sign of high quality (Galak and Nelson, 2011). The two experiments in this dissertation project, in contrast, operated with short sentences, proverbs and couplets. The proverbs, which are still in use and familiar to the majority are mainly short, succinct, and often featuring meter, rhyme, and alliterations (see Menninghaus, Bohrn, Kotz, and Jacobs, in prep.). Although not explicitly assessed, in the case of proverbs and aphorisms people probably value succinctness and ease of processing as a positive sign of quality. Thus, the rating results in the proverbs-experiment become plausible. Future experiments have to investigate the use of the same foregrounding techniques (defamiliarization, word-substitution, rhyme, meter) in the context of literary text to be able to determine the influence of genre-expectations.

To sum up, each study provided evidence that foregrounding techniques influence the affective processing of text. In the meta-analysis, the left amygdala, frequently associated with affective relevance, was found for figurative language processing. In the proverbs-experiment, semantic foregrounding recruited the OFC and medPFC, two regions involved in affective evaluation. In the Busch-experiment, verses with phonological and prosodic foregrounding received more intense and more positive affective ratings then other conditions. Importantly, the standard method of analysing functional data by grouping items into conditions pretends that all readers react comparable on stylistic variations. The complementary analysis explicated in chapter 4 highlights the value of consider-

ing interindividual differences when in comes to affective and esthetic evaluations. Only by modeling the individual beauty ratings, the sensitivity of the caudate nucleus for esthetic pleasure were discovered. This region of the ventral striatum is part of the reward network, suggesting esthetic evaluation based on subjective pleasure during silent reading. Methodologically speaking, these subjective components are only captured with the strongly recommend use of rating scales and physiological measures in addition to functional data.

6.4. Esthetic trajectory

An integral part of the slow route of foreground reading in the model of literary reading is the assumption of an esthetic trajectory (Jacobs, 2011). The concept of the esthetic trajectory highlights the temporal dynamics of extetic experiences and involves three stages: based on an initial stage of familiarity, and recognition, a stage of surprise and ambiguity creates tension. In a third stage this tension is solved through resolution and integration of novel information. Reading is supposed to be slowed down, because the incoming information mismatches activated schemata and expectations, either on the content level or on the formal level. Reactions to such mismatch can be diverse and cover everything from attempts of congnitive mastering, over attention-shifts towards the perceptual process, to emotional reactions of different qualities (interest, confusion, surprise, anger, beauty,...) and are not limited to reading, but observed in a number of esthetic domains (Fitch et al., 2009). Miall (2008) describe this process in terms of *defamiliarization* ad *re*familiarization and it is also found in the model of esthetic percption (Leder et al., 2004) at the stage of cognitive mastering. The proverbs-variants used in chapter 3 (see Appendix for a list of stimuli) were designed to trigger as esthetic trajectory. The deviant word in proverb-variants and proverb-substitutions caught attention and fMRI-data make a process of re-interpretation and re-evaluation likely for proverb-variants. Rather unexpected, this process of re-evaluation was not reflected in higher ratings of liking or interest. Either the process was not accompanied by esthetic emotions, or the emotions elicited were not captured with the selection of rating scales.

6.5. Limitations

The fMRI-experiment presented in chapter 3 and 4 was explorative and pioneer work in the field of neuroaesthetics of reading. So the conclusions drawn from

it are to be treated with caution until they are replicated with different stimuli and participant samples. Without a specific model of the cognitive and affective processes involved in foreground reading, only cautions interpretations of the fMRI results are given. To not be mislead by reverse inference (Poldrack, 2006), it is stated clearly that the regions found in the proverbs experiment (IFG, ACC, OFC, MTG, STG) are not selectively responding to specific cognitive or affective processes. Instead, regions such as the IFG are known to be involved in numerous processes and highly integrative areas. So, although certain areas in the language network are quite reliably associated with specific subprocesses of reading (Price, 2012) the activation patterns do not allow to draw firm conclusions on the cognitive and affective processes involved in foreground reading. The interpretations given in the specific chapters are suggestions from which hypotheses for further experiments have to follow. The focus in this dissertation project was on the neuroanatomical differentiation of foreground- and background reading, so no conclusions about the temporal dynamics can be given. While no differences in lateralization were found in the meta-study and in the fMRI experiment, it cannot be ruled out that the hemispheres differ in the timecourse of processing the meaning of emotional words, as has been shown by Abbassi et al. (2011). A better understanding of the temporal dynamics of esthetic process in reading is also needed for testing the hypothesis of an esthetic trajectory in reading. Ideas to get a better mapping of the temporal dynamics of reading into fMRI-experiments will be elaborated in the following section.

6.6. Outlook

This dissertation project has provided first promising results on the affective and esthetic processes of reading. Although the results can be informative for reading models there is still a long road ahead towards an empirically validated model of literary reading. One challenge for future studies will be to translate the only model of literary reading based on psychological literature (Jacobs, 2011) into more precise and testable hypotheses. The results from the studies presented in chapter 2 and 3 call for a revision of the model: While in both studies distinguishable modes of reading turned out, none of them provides support for a strong lateralization towards the RH for reading foregrounded text. Instead, a mode of foreground-reading seems to be expressed by activity the bilateral IFG, indicating higher salience and enhanced working memory load. However, before making final conclusions these results have to be replicated and validated with different stimulus material.

While changes between background- and foreground-reading can take place on the level of sentences or phrases (Bohrn et al., 2012a,b) and potentially even

on the level of single words (Forgacs et al., 2012), usually literary reading involves reading much longer passages of text. In the experiments presented so far, the entity of the stimulus material has been a sentence with the length of 1-2 lines. Foregrounding effects were successfully demonstrated already at this short distance. However, according to Miall (2008) the relevant entity for foregrounding effects in literature is the episode, which usually covers larger text units. To maximize effects it is thus crucial to use longer text material in future experiments. In the next step towards more ecologically valid stimulus material, short stories or passages from novels have to be adapted for empirical investigations of literary reading, because they might elicit stronger esthetic responses than artificial stimuli. What intuitively sounds trivial is indeed a crucial point, because longer stimulus entities require novel paradigms of stimulus presentation and analysis; at least when it comes to neuroscientific methods. Experimental requirements pose many restrictions on the stimulus material. Ideally, an experiment involves a large number of items per condition only differing on the dimension of interest, with all possible confounds controled. This ideal often is in opposition to the claim for ecological validity according to which one likes to use naturally occurring, unique text material. For instance, to investigate the effect of perspective (first of third person narrator) on the esthetic quality of a text, it will be practically impossible to find even two texts equal on all realevant dimensions (content, complexity, length, structure, etc.), except narrative perspective. In some cases, such conditions can be created by carefully manipulating the text material (e.g. *derhetorizing* poem, or rewriting a text in another narrator perspective). But, one can never be sure if these modifications really do not affect other dimensions as well. So, in most cases, when working with original material the experimenter has to deal with very heterogeneous and unique stimuli which - on top of it all - are most likely to be processed with great interindividual differences. Facing all these difficulties, the empirical investigation of esthetic processes might seem out of reach for many psychological scientists. Literary critics, on the other hand, might fear a reduction to "over-simplified experiments that focus on tiny aspects of literary reading".

In my view, while clean experimental conditions are very difficult to achieve (and quasi-automatically put the reader into an artificial setting), regression analyses help dealing with the diversity of natural stimuli. To account for a large number of text and person variables, the basis for future experiments on esthetic processes in reading needs to be a database of longer text material (poems, short stories, excerpts from novels). For these texts, ratings on several dimensions relevant for affective and esthetic processing have to be obtained (e.g. valence, arousal, imageability, immersion, liking, succinctness, ...), comparable to available databases of single words (Võ et al., 2009, 2006). Ideally, this material is also described in terms of psycholinguistic parameters (word length, frequency, co-occurrence values, phoneme valence) as well as on formal esthetic dimensions

(e.g. genre, number and type of rhetorical figures, rhyme scheme, metric pattern, ...).

This original, unmodified material then has to be read during fMRI-scans while simultaneously recording high frequency eye-movements. The combination of temporally high resolution eye-movement data and spatially high resolution fMRI data potentially allows for a more precise neuro-anatomic differentiation of foreground- versus background reading modes than currently possible. Reading is a serial process and changes between background and foreground reading can potentially happen very quickly. The temporal resolution of fMRI is currently unable to capture such fast alterations. Furthermore, individual differences in reading time make it difficult to capture dynamics within standard fMRI designs. Applying usual fMRI designs, great effort has to be put into constructing text material that only differs in one relevant dimension (Ferstl and von Cramon, 2007). The experiment described in chapter 2 is an example for a standard event-related fMRI design. In ths case the BOLD response is modeled over the whole epoch of stimulus presentation, pretending that the participant had been in a constant mode of foreground- or background-reading per item, which is highly unlikely. This way of modeling the data probably adds much noise, thereby weakening the effect sizes. An alternative design is to externally structure the timing of perception, e.g. through single-word-presentation designs (Yarkoni et al., 2008). Such a design gives the experimenter full control over the reading speed as the timepoint at which a participant reads a specific word is known. Concerning aspects of timing, single-word-presentation makes reading experiments more similar to auditive presentation. As a pitfall, however, numerous components of natural reading are excluded (e.g. refixations, parafoveal preview, etc.). While the limitations of an artificial presentation style might be negligible for some research questions and participants seem to be able to cope quite well with single-word presentation (Yarkoni et al., 2008) it is unclear how this artificial presentation style influences the esthetic perception of text.

When aiming for a maximally ecologically valid reading situation (within the boundary of the per se untypical and uncomfortable situation of reading inside an MRI-scanner), the combination of eye-movement recordings and fMRI holds many benefits: First of all, it can reduce noise in the data by allowing for consideration of eye-movement artifacts (Yarkoni et al., 2008) during the presentation of multi-lined text. Furthermore, this combination of methods is a potential solution for dealing with interindividual differences in reading-speed, given that fixation times are successfully coregistered to the functional data. Ideally, for each individual participant the timepoint of accessing a specific word is identified. I consider this combination of methods a fruitful approach for investigating the neural correlates of foreground- and background- reading, because it allows dealing with a maximum of interindividual variation.

The results from chapter 4 highlight the advantages of using individual ratings to model the BOLD response. Only by implementing the individual ratings as a parametric regressor did beauty-correlated activations in the ventral striatum emerge. According to the model of literary reading (Jacobs, 2011) many variables determine, whether a phrase belongs to the foreground or background of a text. Among them are subject variables such as familiarity with a text, expertise, the reader's repertoire, expectations, or mood. No experimental design is able to control for all these interindividual differences but in the analysis of neuronal data they can be modeled. In the style of Speer et al. (2007), the coding of background and foreground parts in a text can be modeled based on subjective ratings of the participants (thereby accounting for the subject-related variables from the Jacobs model). Additionally or alternatively, a text can be coded by experts in the field of literature, who identify foregrounded passages based on e.g. rhetoric figures and tropes. Currently, cluster collegues Philipp Engel and Moritz Lehne are validating techniques for continuous online ratings of affect while participants read stories or listen to music. Such an approach seems fruitful as well. Numerous related questions can be investigated with this combinatorial approach: To investigate the influence of motivational factors, text has to be read under different task conditions. In how far is reading for pleasure comparable to reading for information collection, reading in anticipation of a memory test, or reading while giving continuous valence ratings? Another issue on a future agenda is the influence of readers' expectation and experience by compering foreground-reading in relatively naive readers (people who rarely read, and/or have little interest in literature) to experts (people who read a lot and have great knowledge about literature).

As discussed in chapter 4, experimental aesthetics can take two main perspectives. Experiments can either be designed to discover general stimulus properties perceived as beautiful by the majority of people. Alternatively, they can focus on the ideosyncratic nature of aesthetic evaluations, to investigate "beauty in the eye of the beholder". Based on the results from this dissertation I assume a mixture of general and individual components also when it comes to esthetic processes in reading. The studies presented in chapter 2, 3 and 5 discovered shared processing mechanisms: The meta-analysis identified differences in processing literal and figurative language across a number of studies and participants. From the experiment on proverbs a general preference for familiar, fluent and easy to process sentences becomes evident, which is in line with the behavioral results presented in chapter 5. The re-analysis of the proverb-experiment in chapter 4 additionally highlights individual differences. Despite a general tendency for participants to like what they know, individual variations have to be modeled to uncover activation in reward-related brain areas.

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Appendices

A. Appendix

A.1. List of stimuli used for the studies from chapter 3 and 4

Table A.1.: **Experimental conditions**

Familiar proverbs	**proverb-substitutions**	**proverb-variants**
Wissen ist Macht.	**Kenntnis** ist Macht.	**Gewissen** ist Macht.
Wer **wagt**, gewinnt.	Wer **riskiert**, gewinnt.	Wer **fragt**, gewinnt.
Reden ist Silber, **Schweigen** ist Gold.	Reden ist Silber, **Stille** ist Gold.	Reden ist Silber, **Helfen** ist Gold.
Je später der Abend, desto schöner die **Gäste**.	Je später der Abend, desto schöner die **Besucher**.	Je später der Abend, desto schöner die **Gesten**.
Ende gut alles gut.	**Schluss** gut, alles gut.	**Rente** gut, alles gut.
Gut Ding will **Weile** haben.	Gut Ding will **Zeit** haben.	Gut Ding will **Freude** haben.
Die Zeit heilt alle **Wunden**.	Die Zeit heilt alle **Schmerzen**.	Die Zeit heilt alle **Wunder**.
Übung macht den **Meister**.	Übung macht den **Könner**.	Übung macht den **Muskel**.
Eine Hand **wäscht** die andere.	Eine Hand **reinigt** die andere.	Eine Hand **wärmt** die andere.
In der **Ruhe** liegt die Kraft.	In der **Stille** liegt die Kraft.	In der **Natur** liegt die Kraft.
Jeder **Topf** hat einen Deckel.	Jeder **Pott** hat einen Deckel.	Jeder **Sarg** hat einen Deckel.
Auch Rom ist nicht an einem Tag **erbaut** worden.	Auch Rom ist nicht an einem Tag **erstellt** worden.	Auch Rom ist nicht an einem Tag **zerstört** worden.
Ein gesunder **Geist** wohnt in einem gesunden Körper.	Ein gesunder **Sinn** wohnt in einem gesunden Körper.	Ein gesunder **Schnaps** wohnt in einem gesunden Körper.
Andere Zeiten, andere **Sitten**.	Andere Zeiten, andere **Bräuche**.	Andere Zeiten, andere **Männer**.
Alle **Wege** führen nach Rom.	Alle **Pfade** führen nach Rom.	Alle **Sünden** führen nach Rom.
Geld allein macht nicht **glücklich**.	Geld allein macht nicht **fröhlich**.	Geld allein macht nicht **ehrlich**.
Früh übt sich, wer ein **Meister** werden will.	Früh übt sich, wer ein **Könner** werden will.	Früh übt sich, wer ein **Rentner** werden will.
Vorsicht ist die Mutter der **Porzellankiste**.	Vorsicht ist die Mutter der **Glasvitrine**.	Vorsicht ist die Mutter der **Karriere**.
Sauer macht **lustig**.	Sauer macht **freudig**.	Sauer macht **durstig**.
Handwerk hat **goldenen** Boden.	Handwerk hat **edlen** Boden.	Handwerk hat **harten** Boden.
Ein **Unglück** kommt selten allein.	Ein **Schaden** kommt selten allein.	Ein **Zwilling** kommt selten allein.
Keine Rose ohne **Dornen**.	Keine Rose ohne **Spitzen**.	Keine Rose ohne **Duft**.
Müßiggang ist aller **Laster** Anfang.	Müßiggang ist aller **Fehler** Anfang.	Müßiggang ist aller **Freude** Anfang.

Wer Wind säht, wird **Sturm** ernten.	Wer Wind säht wird **Orkan** ernten.	Wer Wind säht, wird **Energie** ernten.
Wer nicht hören will muss **fühlen**.	Wer nicht hören will muss **spüren**.	Wer nicht hören will, muss **lesen**.
Wer schön sein will muss **leiden**.	Wer schön sein will muss **erdulden**.	Wer schön sein will muss **genießen**.
Viele Köche **verderben** den Brei.	Viele Köche **ruinieren** den Brei.	Viele Köche **kreieren** den Brei.
Wer hoch steigt, kann tief **fallen**.	Wer hoch steigt, kann tief **stürzen**.	Wer hoch steigt, kann tief **schauen**.
Ordnung ist das halbe Leben.	**System** ist das halbe Leben.	**Neugier** ist das halbe Leben.
Gelegenheit macht **Diebe**.	Gelegenheit macht **Räuber**.	Gelegenheit macht **Liebe**.
Der Fisch fängt vom Kopf her an zu **stinken**.	Der Fisch fängt vom Kopf her an zu **muffeln**.	Der Fisch fängt vom Kopf her an zu **trinken**.
Geld regiert die Welt.	**Gold** regiert die Welt.	**Neid** regiert die Welt.
Liebe macht blind.	**Verliebtheit** macht blind.	**Werbung** macht blind.
Was der Bauer nicht kennt, **frisst** er nicht.	Was der Bauer nicht kennt, **isst** er nicht.	Was der Bauer nicht kennt, **melkt** er nicht.
Zeit **ist** Geld.	Zeit **bedeutet** Geld.	Zeit **frisst** Geld.
Alter hilft vor Torheit nicht.	**Bejahrtheit** hilft vor Torheit nicht.	**Bildung** hilft vor Torheit nicht.
Sport ist **Mord**.	Sport ist **Tötung**.	Sport ist **Mode**.
Rache ist **süß**.	Rache ist **süßlich**.	Rache ist **fies**.
Der Mensch denkt, **Gott** lenkt.	Der Mensch denkt, **Herrgott** lenkt.	Der Mensch denkt, **Computer** lenkt.
Kleider machen **Leute**.	Kleider machen **Menschen**.	Kleider machen **Neider**.

Table A.2.: **Control conditions**

non-rhetorical sentences	**unfamiliar proverbs**
Etwas Sport ist gesund.	Jahre lehren mehr als Bücher.
Lachen entspannt im Alltag.	Gutes Essen lässt Sorgen vergessen.
Kerzen machen einen Raum heller.	Heiter kommt weiter.
Offene Menschen haben viele Freunde.	Andrer Mann, andres Glück.
Wissen ist im Beruf nützlich.	Einfalt hat schöne Gestalt.
Ein Hausbau braucht viel Zeit.	Kleiner Mann, großes Herz.
Jeder Schmerz endet irgendwann.	Nicht alle Wolken regnen.
Ruhige Leute ertragen Stress gut.	Kluge Leute fehlen auch.
Was man gut kann, macht Spaß.	Adler fangen keine Mücken.
Fleiß führt oft zum Erfolg.	Natur geht vor Lehre.
Fast jeder findet mal einen Partner.	Was der Löwe nicht kann, das kann der Fuchs.
Man soll das Leben heiter verbringen.	Die Wahrheit ist zu schlau um gefangen zu werden.
Mit Training stärkt sich der Körper.	Wer will, was er kann, fängt nichts vergeblich an.
Ein Witz lockert die Stimmung.	Neuer Freund, neuer Wein.
Salz hebt den Geschmack.	Das Herz lügt nicht.
Ein Reicher hat im Leben kaum Sorgen.	Das Glück muss man erobern.
Kinder sollte man jung fördern.	Was nicht rastet und nicht ruht, tut in die Länge nicht gut.

Man sollte nicht lang zornig sein.
Den Müll zu trennen ist klug.
Gemüse ist so gesund wie Obst.
An Feiertagen gibt es oft Stau.
Auch das Schöne hat Nachteile.
Brüder kämpfen oft um das Erbe.
Pflanzen, die man nicht gießt, welken.
Viele Beziehungen halten nicht.
Für Schönheit wird zu viel Geld vergeudet.
Jemand schwaches ist eher hilflos.
Ohne Geld gehen Firmen pleite.
Mit Hektik richtet man nur Schaden an.
Es ist schwer Fehler zu gestehen.
Schlechte Anführer schaden der Gruppe.

Naive Leute werden ausgenutzt.
Ein Gerücht wird rasch weiter erzählt.
Im Winter muss man viel anziehen.
Man sollte Zeit nicht vergeuden.
Zu laute Musik schadet den Ohren.
Wer feig ist hat oft Angst.
Einsamkeit macht viele Leute krank.
Sorgen drücken auf die Laune.
Alkohol macht eher gereizt.

Behaupten ist nicht beweisen.
Der Edle zürnt nicht lange.
Besser umkehren als irregehn.
Karges Weib geht oft zur Kiste.
Kalt Eisen brennt nicht.
Besser karg als arg.
Besser beneidet als beklagt.
Nesseln brennen Freund und Feinde.
Das Böse glaubt man gern.
Ein einzelner Armreif klappert nicht.
Das Alte klappert, das Neue klingt.
Pfaffen segnen sich zuerst.
Bosheit ist bald gelernt.
Besser die Hand in einem Kuhfladen denn in fremdem Gelde.

Bruderzwist gar heftig ist.
Den Esel will jedermann reiten.
Jeden Morgen neue Sorgen.
Amt ohne Sold macht Diebe.
Kein Kranz schützt vor Kopfweh.
Geschieht's, man sieht's.
Borgen tut nur einmal wohl.
Viel Wissen, wenig Gewissen.
Ein fauler Apfel macht zehn.

Erklärung

Die Studien dieser Dissertationsschrift wurden in marginal modifizierten Versionen in internationalen Fachzeitschriften veröffentlicht oder stehen kurz vor der Einreichung :

Studie 1:
Bohrn, I. C., Altmann, U., and Jacobs, A. M. (2012). Looking at the brains behind figurative language: A quantitative meta-analysis on metaphor, idiom, and irony processing. *Neuropsychologia, 50*(11), 2669-2683.

Studie 2:
Bohrn, I. C., Altmann, U., Lubrich, O., Menninghaus, W., and Jacobs, A. M. (2012). Old proverbs in new skins - an FMRI study on defamiliarization. *Frontiers in psychology, 3*:204.

Studie 3:
Bohrn, I. C., Altmann, U., Lubrich, O., Menninghaus, W., and Jacobs, A. M. (2013). When we like what we know - A parametric fMRI analysis of beauty and familiarity. *Brain and Language, 124*:1-8

Studie 4:
Menninghaus*, W., Bohrn*, I. C., Altmann, U., Lubrich, O., and Jacobs, A. M. (2013). Sounds funny? - Humor effects of phonological and prosodic figures of speech. Kapitel 5 stellt eine adaptierte Version dieser interdisziplinären Publikation dar, die kurz vor der Einreichung bei Psychological Science steht
* geteilte Erstautorenschaft

Die angeführten Ko-Autoren können bestätigen, dass ich für das Entstehen dieser Studien hauptverantwortlich war. Hiermit versichere ich, dass ich die vorliegende Arbeit selbständig verfasst habe. Andere als die angegebenen Hilfsmittel habe ich nicht verwendet. Die vorliegende Arbeit war nicht Gegenstand eines anderen Promotionsverfahrens.

Berlin, den 09. Dezember 2012

(Isabel C. Bohrn)