Fachbereich Erziehungswissenschaft und Psychologie
der Freien Universität Berlin

Beyond beauty - affective and aesthetic processes in reading and art perception

Dissertation
zur Erlangung des akademischen Grades
Doktorin der Philosophie (Dr. phil.)

vorgelegt von
Dipl. Psych. Ulrike Altmann

Berlin, 2017

Erstgutachter:
Univ.-Prof. Dr. Arthur M. Jacobs (Freie Universität Berlin)

Zweitgutachter:
Prof. Dr. phil. Lars Kuchinke (International Psychoanalytic University Berlin)

Datum der Disputation: 27.02.2018

Danksagung

The Road Not Taken

Two roads diverged in a yellow wood,
And sorry I could not travel both
And be one traveler, long I stood
And looked down one as far as I could
To where it bent in the undergrowth;

Then took the other, as just as fair,
And having perhaps the better claim,
Because it was grassy and wanted wear;
Though as for that the passing there
Had worn them really about the same,

And both that morning equally lay
In leaves no step had trodden black.
Oh, I kept the first for another day!
Yet knowing how way leads on to way,
I doubted if I should ever come back.

I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and I —
I took the one less traveled by,
And that has made all the difference.

By Robert Frost

Erschöpft, aber zufrieden danke ich am Ende einer langen Reise allen, die mich begleitet, gefördert, aber auch gefordert und inspiriert haben.
Voller Vorfreude betrete ich nun neue Wege und es ist mein größtes Geschenk, einige von Euch als Weggefährten an meiner Seite zu wissen.

Abbreviations

CBDTE	Computational belief-desire theory of emotion
DMN	Default mode network
fMRI	Functional magnetic resonance imaging
FPN	Frontoparietal control network
NCPM	Neurocognitive poetics model
PPI	Psychophysiological interaction
ToM	Theory of mind
TPJ	Temporo-parietal junction
STS	Superior temporal sulcus
dmPFC	Dorsomedial prefrontal cortex
PMC	Posteromedial cortex (i.e., precuneus, posterior cingulate, and medial superior parietal cortex)
vmPFC	Ventromedial prefrontal cortex
AI	Anterior insula
mCC	Midcingulate cortex
AMY	Amygdala
SII	Secondary somatosensory cortex
IFG	Inferior frontal gyrus

Summary

Why do we read literature? Why should we invest life time in reading and thinking about fictional characters having fictional emotions and fictional problems? I am not good in painting - Why should I care about art? Questions like these were regularly asked by children and often by their parents, too. They should be taken seriously - the engagement with non-expository texts or, e.g., representational art is implemented in educational systems all over the world. Our life is full of stories: some of them depict real-life events and were reported, e.g. in the daily news or in autobiographies, whereas other stories, as often presented to us in movies and novels, are fictional. The comprehension of stories requires the reader to imagine the cognitive and affective states of the characters; the content of many narrative texts is unpleasant, as they often deal with conflict, disturbance or crisis. Nevertheless, unpleasant stories can be liked and enjoyed. However, we have only little insights in the neurocognitive processes underlying the reading of (literary) narratives.

This dissertation aimed to throw light upon the following questions: (1) Do we feel 'real' emotions when reading literature? (2) Have narrative texts the potential to invite the reader feeling empathy for (often fictional) characters? (3) Elicit factual and fictional contents different neural processes? (4) Has representational art the potential to evoke empathic responses in the perceiver?

To answer the first three questions, they were operationalized according to the Neurocognitive Poetics Model by Jacobs (NCPM, 2011; 2015a, b), and a set of 80 short narratives was compiled, ranging from neutral to negative emotional valence. The narratives were used as stimulus material in two study 1 and 2. In a first fMRI study (Chapter 2), we used a parametric approach to examine (1) the capacity of increasing negative valence of story contents to activate the mentalizing network (cognitive and affective theory of mind, ToM), and (2) the neural substrate of liking negatively valenced narratives. Results revealed a stronger engagement of affective ToM-related brain areas with increasingly negative story valence. Stories that were unpleasant, but simultaneously liked, engaged the medial prefrontal cortex (mPFC), which might reflect the moral exploration of the story content. Further analysis showed that the more the mPFC becomes engaged during the reading of negatively valenced stories, the more coactivation can be observed in other brain areas related to the neural processing of affective ToM and empathy.

In a second fMRI study (Chapter 3), the neurocognitive effects of reading short narratives, labeled to be either factual or fictional have been investigated. Reading in a factual mode engaged an activation pattern suggesting an action-based reconstruction of the events depicted in a story. This process seems to be past-oriented and leads to shorter reaction times at the behavioral level. In contrast, the brain activation patterns corresponding to reading fiction seem to reflect a constructive simulation of what might have happened. This is in line with studies on imagination of possible past or future events.

In a third fMRI experiment (Chapter 4), the aesthetic experience of art during free viewing was compared with judgment-oriented viewing of paintings. In the latter condition, we observed activation in the orbitofrontal cortex (OFC), dorsolateral prefrontal cortex (DLPFC), inferior frontal gyrus (IFG), dorsal anterior cingulate cortex (dACC) and anterior insula (AI), indicating the anticipation of participants' subsequent liking judgments. In contrast, the free viewing of artworks elicited brain responses related to affective mentalizing in the ventromedial prefrontal cortex (vmPFC) and the posterior cingulate cortex (PCC), in the temporal poles (TP), temporoparietal junction (TPJ), and the amygdala, presumably reflecting the attempt of the beholder to understand the intentions behind an artwork and to read out affective signals of the depicted contents, thus actively constructing meaning.

Taken together the data provide strong evidence that empathy and mentalizing constitute key factors for meaningful experiences with literary and representational art.

Zusammenfassung

Warum lesen wir Literatur? Warum sollten wir Lebenszeit in das Lesen und Nachdenken über fiktionale Charaktere mit fiktionalen Emotionen und fiktionalen Problemen investieren? Ich bin selbst nicht gut im Malen - warum sollte ich mich für Kunst interessieren? Fragen wie diese werden regelmäßig von Kindern und oftmals auch von deren Eltern gestellt. Man sollte diese Fragen ernst nehmen - die Auseinandersetzung mit anderen, als rein erklärenden, Texten und darstellender Kunst bildet einen wichtigen Bestandteil von Bildungssystemen weltweit. Unser Leben ist erfüllt von Geschichten: einige von ihnen beinhalten reale Ereignisse und werden z.B. durch die täglichen Nachrichten oder durch Autobiografien übermittelt, während andere Geschichten, die wir aus dem Kino oder aus Romanen kennen, fiktional sind. Das Verstehen von Geschichten erfordert vom Leser, dass er sich in die Gedanken und Gefühle der Protagonisten hineinversetzt, wobei der Inhalt vieler narrativer Texte negativ konnotiert ist, weil diese Texte Konflikte, Störungen oder Krisen thematisieren. Dennoch können negativ-valente Texte vom Leser gemocht und genossen werden.

Zielsetzung hinter dieser Dissertation war es, folgende Fragen näher zu beleuchten: (1) Fühlen wir 'reale' Emotionen beim literarischen Lesen? (2) Besitzen narrative Texte das Potential, im Leser Empathie für die - oftmals fiktionalen - Charaktere zu evozieren? (3) Gehen faktuale und fiktionale Inhalte mit unterschiedlichen neuronalen Verarbeitungsprozessen einher? (4) Vermag auch darstellende Kunst empathische Reaktionen im Betrachter auszulösen?

Zur Beantwortung der ersten drei Fragen wurden diese mittels des neurokognitiven Arbeitsmodells literarischen Lesens von Jacobs (NCPM, 2011; 2015a, b) operationalisiert; außerdem wurde ein Korpus erstellt, bestehend aus 80 Texten mit neutraler bis negativer Valenz und einer narrativen Struktur. Dieses Textmaterial fand Verwendung in den Studien 1 und 2 (siehe die Kapitel 2 und 3). In einer ersten fMRT Studie nutzten wir einen parametrischen Ansatz, um zu untersuchen, inwieweit die steigende negative Valenz der kurzen Geschichten das Mentalisierungs-Netzwerk (= Theory of Mind, ToM) auf kognitiver und affektiver Ebene involviert. Außerdem wurde die neuronale Repräsentation negativ-valenter, aber dennoch gemochter Geschichten untersucht. Die Ergebnisse offenbarten eine stärkere Aktivierung ToM-bezogener Hirnareale mit zunehmender negativer Valenz. Geschichten, die zwar eine sehr

negative Valenz aufzeigten, aber dennoch gemocht wurden, aktivierten den medialen präfrontalen Kortex (mPFC), was vermutlich die moralische Evalution des Textinhaltes wiederspiegelt. Weitergehende Analysen zeigten: je stärker die Aktivierung des mPFC während des Lesens negativ-valenter Texte, desto stärker die beobachtbare Co-Aktivierung von ToM und Empathie verarbeitenden Hirnarealen.

Im Rahmen einer zweiten fMRT-Studie wurden die neurokognitiven Effekte bezogen auf das Lesen von als faktual oder fiktional gekennzeichneten Texten untersucht. Das Lesen vermutlich faktenbasierter Inhalte evozierte ein Aktivitätsmuster, welches für eine handlungsbasierte Rekonstruktion der geschilderten Ereignisse spricht. Dieser Prozess scheint vergangenheitsbezogen und ging mit schnelleren Reaktionszeiten auf behavioraler Ebene einher. Im Gegensatz dazu scheinen die Aktivierungsmuster, welche auf der Verarbeitung vermeintlich fiktionaler Inhalte basieren, eine konstruierende Simulation dessen, was passiert sein könnte, widerzuspiegeln - ähnlich, wie es in Studien zur Imagination möglicher vergangener oder zukünftiger Ereignisse gefunden wurde.

In einem dritten fMRT-Experiment wurde die ästhetische Erfahrung während des freien Betrachtens mit dem Urteilsbezogenen Betrachten verglichen. In letztgenannter Bedingung ließen sich Aktivierungen, die für eine Antizipation des folgenden Gefallens-Urteils sprechen beobachten; im orbitofrontalen Kortex (OFC), im dorsolateralen präfrontalen Kortex (DLPFC), im inferioren Frontalgyrus (IFG), im dorsalen anterioren cingulären Kortex (dACC), sowie der anterioren Insel (AI).

Im Vergleich evozierte das freie Betrachten von Kunstwerken Hirnaktivierungen, die mit dem affektiven Mentalisieren assoziiert sind; im ventromedialen präfrontalen Kortex (vmPFC), sowie dem posterioren cingulären Kortex (PCC), den Temporalpolen (TP), der temporoprietalen Junktion (TPJ) und der Amygdala. Diese Aktivierungen liegen vermutlich dem Versuch des Betrachters zugrunde, die Intentionen hinter einem Kunstwerk zu verstehen und affektive Signale des dargestellten Inhaltes auszulesen, wobei aktiv Bedeutungen erzeugt werden.

Zusammenfassend bieten die Daten starke Evidenz dafür, dass Empathie und ToM-Prozesse Schlüsselfaktoren sind für bedeutsame ästhetische Erfahrungen mittels Literatur und darstellender Kunst.

List of publications

Altmann, U., Bohrn, I. C., Lubrich, O., Menninghaus, W., & Jacobs, A. M. (2012). The power of emotional valence—from cognitive to affective processes in reading. *Frontiers in Human Neuroscience*, *6*, 192. http://doi.org/10.3389/fnhum.2012.00192

Altmann, U., Bohrn, I. C., Lubrich, O., Menninghaus, W., & Jacobs, A. M. (2014). Fact *vs* fiction—how paratextual information shapes our reading processes. *Social Cognitive and Affective Neuroscience*, *9*(1), 22–29. http://doi.org/10.1093/scan/nss098

Altmann, U., Jacobs, A. M., Wilke, S., & Leder, H. (2017). *Beyond Beauty - Art as a canvas to social cognition, an fMRI study*. Article under review.

Hsu, C. T., Jacobs, A. M., Altmann, U., & Conrad, M. (2015). The magical activation of left amygdala when reading Harry Potter: An fMRI study on how descriptions of supra-natural events entertain and enchant. *PloS one, 10*(2), e0118179.

Lubrich, O., Altmann, U., Bohrn, I. C., Menninghaus, W., Jacobs, A. M. (2013). "Den emosjonelle valensens kraft – fra kognitive til affektive leseprosesser". Bøygen, 2013(1), S. 78-99. Institutt for litteratur, områdestudier og europeiske språk Oslo.

List of figures

List of tables

Table of contents

1. Introduction

1.1. Theoretical background

1.1.1. Along the lines

"Nothing is more romantic than what we commonly call the world and destiny—We live in a colossal novel"
(Novalis)

In a way, every book has something fateful about it: Every occurrence is determined. The beginning, the end, the nuance of every event that is painted in a narrative work is printed between a front and a back cover. And no matter how the readers respond to the work, no matter what emotions, thoughts, or bodily reactions they exhibit, its content will unfold unaffected and thereby unconditionally honestly. According to Kiergegaard, this 'indirect communication' makes literature an art (see Djikic & Oatley 2014; Oatley, 2016). Neither a protagonist nor the author of the text will adopt to any behavior of the recipient, who instead can (and must) follow, imagine, or analyze events whose denouements are already fixed.

This engagement with the narrative world allows the reader to experience a depth and intensity rarely provided by daily experiences. In the course of daily interactions, we have to deal with having access to only limited information about the thoughts, emotions, or motives of others. Accordingly, we have to build our theory of another's mind on many inferences. In such situations, it could be helpful to be familiar with a similar constellation with similar constraints, as well as to have knowledge about possible solutions and outcomes. Reading (especially fiction) can function as a "moral laboratory" (Haakemulder, 2000) and provide us with a deeper understanding of others and ourselves. As Oatley (1999) has stated, fiction can be truer than fact.

The history of humanity's understanding of the function of fiction traces back to Aristotle and his concept of mimesis. Mimesis was often translated and discussed as imitation or representation. However, modern readings have suggested that simulation might be a better interpretation of the concept (Oatley 1995, 1999), with its emphasis on the mind's constructive processes and their focus on social relationships (*simulation hypotheses*). Oatley & Olsen (2010) have argued that factual and fictional entities follow different tasks, stating that the aim of real-world interaction lies in cooperation and alignment while the task of fictional interaction is imagination and simulation.

1.1.2. What is literariness?

"*The author whom a lexicon can keep up with is worth nothing.*"
(Johann Wolfgang von Goethe)

Experiments have demonstrated that literary texts have a particular capacity to elicit at least short-term effects on measures of personality (Djikic, Oatley, Zoeterman, & Peterson, 2009; Richter et al., 2014; see Sestir & Green, 2010 for similar effects of film), to change beliefs with respect to the 'real' world (Gerrig & Rapp, 2004; Green, 2004) with increasing efficacy over time (Appel & Richter, 2007), and to improve mentalizing and social abilities (Mar, Oatley, Djikic, & Mullin, 2006; Kidd & Castano, 2013).

This raises the following daunting question: What is literariness? Trying to answer this question is like attempting to define the color of a chameleon. Accordingly, the answers given so far varied between the search for text inherent properties (Jakobsen, 1960; Mukařovský, 1970; Shklovsky & Berlina, 2015), including genre signals (Hamburger, 1973), and the conceptualization of literariness as a construction of meaning on the basis of interpretive strategies that reflect cultural and social conventions (cf. Zwaan, 1993).

Literature in its early meaning (from lat. *litterātūra* 'grammar', derived from lat. *littera* 'letter') referred to all kinds of writing, including scientific writing, up to the 18th century. Later, the focus moved towards *belles-lettres* ('fine writing') and aesthetic evaluation (Lamarque & Olsen, 1994). In this view, the answer to the question of 'what is literature' is inherently subjective and not constant over time. Both expert and non-expert readers regularly publish often very different lists of works that they appreciate (Fabelhafte-buecher.de, 2017a, b). A valuable account of this process came from Miall and Kuiken (1999), who studied the interrelation between a text and its reader. The authors proposed an interaction of three components: (a) defamiliarizing elements of textual or narrative foregrounding, (b) the reader's responses to them, and (c) the construction of meaning and transformation of feelings. Later, the dual route model of neurocognitive poetics (*NCPM; Jacobs,* 2011; 2015a,b) built on these findings and integrated these ideas as a foreground-driven route to literature reception by contrast with a background-driven route.

1.1.3. The neurocognitive poetics model of literary reading

"The most useful books are those of which readers themselves compose half."

(Voltaire)

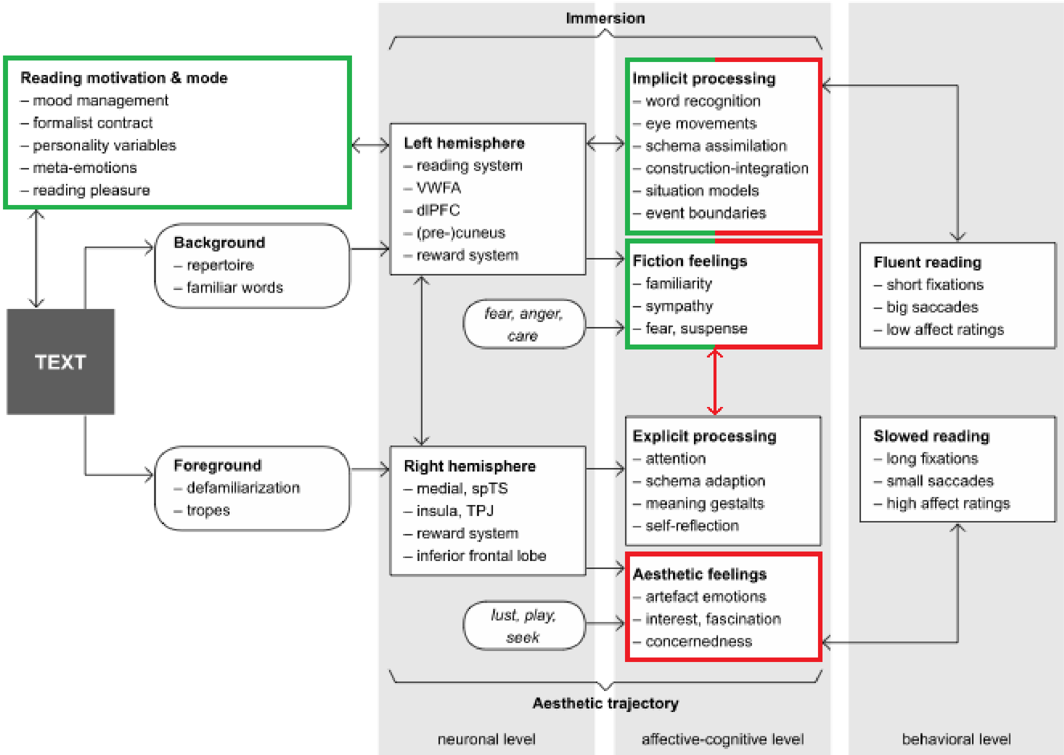


Figure 1.1. The neurocognitive poetics model of literary reading by Jacobs (simplified version, abstracted from Figure 7.2 of Jacobs, 2014).

The neurocognitive poetics model (NCPM) of literary reading (*Jacobs,* 2011; 2015a, b) provides hypotheses regarding engagement with artistic language covering three levels of investigation: (1) neuronal, (2) affective-cognitive, and (3) behavioral. The model invites further investigation from research and is open to continuous adaptation in order to gain a deeper understanding of the cognitive, affective, and aesthetic processes that characterize engagement with narrative (poetic) texts.

The NCPM suggests a ‘dual-route’ processing (Figure 1.1):

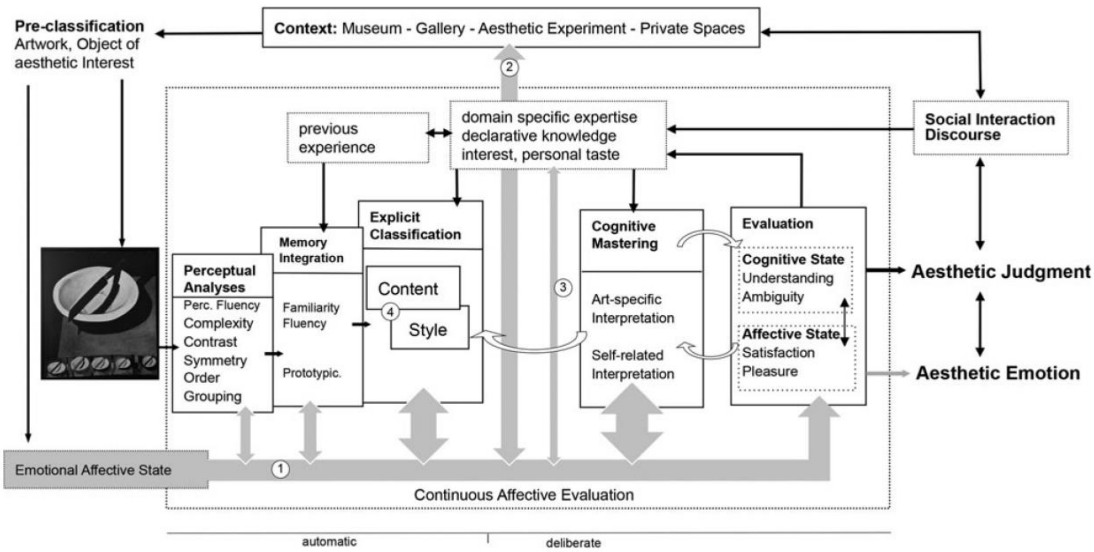
(a) a fast route based on the effortless, implicit processing of textual background information is hypothesized to facilitate immersion in a text (similar concepts are known as transportation, absorption, or flow).

(b) a slow route based on explicit, attentive processing of textual foreground information (defamiliarization) is hypothesized to facilitate aesthetic and meaningful reading experiences.

Within the NCPM, the focus is set on the act of reading, which covers a time span from seconds to minutes, and which constitutes one sequence of the reading experience. The model builds its assumptions on the experience of readers, who independently read a (literary) text in the form of prose. The act of being read to (e.g. by audiobooks) is not explicitly commented on in terms of whether it lies within the scope of the model’s coverage or not. It might be a subject for future research to clarify, to what extent the neurocognitive model of literary reading covers the recipient’s experience in another modality. The same applies for poetics (but see Jacobs, Lüdtke, & Meyer-Sickendiek, 2013).

Central to my work is the influence of context (*modulation-by-context hypothesis*, cf. section 1.1.4.) on affective and aesthetic processes in reading (and art perception, see Chapter 4), as well as the fiction-feeling component of the NCPM. The *fiction-feeling hypothesis* postulates that emotional contents in narratives "invite readers [...] to be empathic with the protagonists and immerse in the text world (e.g., by engaging the affective empathy network [...])" (Jacobs, 2015a, p. 2). As language itself is not an object of emotion but refers to objects of emotion and/or action, Jacobs (2015a) introduces a second hypothesis, which states that the neuronal networks underlying the processing of reading narratives "must be linked to the ancient emotion circuits we share with all mammals" (*Panksepp-Jakobson hypothesis;* Jacobs, 2015a, p. 3; Panksepp, 2008). Continuously, growing evidence of (neuroscientific) research further informs the model (Bohrn et al., 2012; 2013; Citron, Güsten, Michaelis, & Goldberg, 2016; Hsu, Conrad, & Jacobs, 2014; Jacobs, Lüdtke, & Meyer-Sickendiek, 2013).

A decade before the NCPM was introduced Leder, Belke, Oeberst, & Augustin (2004) provided a boxological model for the domain of visual art (Figure 1.2. The model proposed the aesthetic experience of art perception a process of cognitive mastering, which is informed continuously through affective evaluation. In contrast to the NCPM, Leder and colleagues (2004; see also Leder & Nadal, 2014) assume cognitive and affective processes to be intertwined.



Model of Aesthetic Experiences (adpated from Leder, Belke, Oeberst & Augustin, 2004). Painting by HL.

Figure 1.2. The updated model of aesthetic appreciation and aesthetic judgments (abstracted from Leder & Nadal, 2014).

1.1.4. Literature, fiction, reality, and truth

"*Truth is the invention of a liar*"

(Foerster; see Foerster & Pörksen, 1998)

The NCPM (*Jacobs,* 2011; 2015a, b) accounts for context variables that influence the reading process even before the recipient opens a book. Such a variable is the so-called 'paratext' (Genette, 1990) arising from cover details such as the title, or the name of the author. Genre signals provide essential knowledge to the reader (e.g. whether the text is a novel, crime story, or autobiography) and are associated with certain expectations. As Gerrig & Rapp (2004) were able to show, readers expect truthfulness with respect to the 'real' world. Violations of such expectations often lead to heated debate, as in the case of Benjamin Wilkomirski, when it emerged that his 'autobiography' about surviving the holocaust was in fact a fictional story (see Klüger, 2006, for a detailed discussion). In the domain of art, similar reactions can be observed. An example is when it became apparent in 2010 that the German artist Wolfgang Beltracchi had forged and sold numerous paintings of famous artists. Both examples illustrate the importance of contextual factors for tracing any aesthetic trajectory besides the specific properties of a piece of art, such as form and content (for the domain of art, see Leder & Nadal, 2014; Jacobs & Willems, 2017).

Nevertheless, can any narrative actually tell the truth? The lessons learned from narrative psychology reveal a fluid boundary between 'reality' on the one hand and fiction on the other. Narrative therapeutic approaches emerged when attention shifted from *what* a client reported to *how* people talk about conflicts, and their approaches to problems, thereby creating meanings. From this point of view, "reality consists of nothing but stories; these are what people really talk about." (transl. from v. Schlippe & Schweitzer, 2007, p. 40).

We know that even the sensory perception of our environment is a result of numerous (highly efficient) chemical and neuronal interpretative processes. Because these processes 'run' both speedily and continuously on our biological 'hardware', we experience constancy within the permanent construction of reality. In order to communicate about the perceived (internal and external) events and thoughts, we select and interpret our perceptions anew, until a verbal utterance is made [As Roman Jacobsen (1989) argued: "Jede verbale Äußerung stilisiert und transformiert in gewissem Sinn die Begebenheit, welche sie schildert." (p.75.)]. Thus, the content of narratives must not be 'real' in a narrow sense, but relevant (Rossi et al., 2003), and thus realistic (Green, 2004). Fiction has especial potential in evoking emotion in the reader who sympathizes with the protagonists (and the protagonist's emotions) in the narrative world. Poetic language can defamiliarize the concepts of the reader and put the apparently inexpressible (feelings) into new words (Lieberman et al., 2007).

1.1.5. Can (fictional) artworks elicit ‘real’ emotions?

"*For there is nothing either good or bad, but thinking makes it so*"
(Shakespeare: Hamlet, Act 2, Scene 2)

A common basic assumption of many theories on emotion is the object-relatedness of emotions. Thus, emotions have intentional objects - one is not just happy or sad, but happy or sad *about* something. This something, the object of an emotion, can be a certain state of affairs, such as an action or an event. An emotion accordingly presupposes the belief in the existence of its object, as well as appraising or evaluating the belief as either *good* or *bad* for oneself (Arnold, 1960; Frijda, 2009; Lazarus, 1991; Reisenzein & Junge, 2012; Scherer, 1999; for an overview, see Moors, Ellsworth, Scherer, & Frijda, 2013).

With respect to art, a distinction can be made between emotions towards the represented figures, and emotions towards the represented emotional triggers. It is possible, for example (cf. Friese, 2017), that readers of Stephan King’s novel "It" not only experience fear for the protagonists (fear towards represented figures); it might so happen that a reader, even months after finishing the book, eyes puddles suspiciously or inspects the sink drain with an uneasy, fearful feeling; Pennywise, after all, could be anywhere (fear towards the represented emotional triggers).

However, it has been questioned whether emotions such as those involving figures in a book or the triggers those figures are confronted with, are 'real' emotions. The presupposition, in particular, of the common emotion theory that emotions have intentional objects raises a problem, known as the ‘paradox of fiction’:

a. Emotional responses presuppose a belief in the existence of the object of emotion.

b. The content of books, films, and artworks can elicit strong emotional responses in recipients,

c. although they are quite aware of the nonexistence of the depicted figures, scenes, or events and the fact they do not believe them to be real.

An influential theory developed in order to solve the paradox is Kendall Walton’s theory of make-believe. Kendall Walton (1978, 1990) introduced the concept of quasi-emotions within a kind of pretend play while reading fiction. He argued that, in order to more fully appreciate the reading process, the reader engages with the content of a story as if it were real by establishing a willing suspension of disbelief. Lamarque (1981) questioned the idea of disbelief and quasi-emotions, stating that the object of an emotion can be fictional, but not the emotion itself that has been stimulated by the object: "We can reflect on, and be moved by, a thought independently of accepting it as true. This in turn accounts for the intuition that belief and disbelief stay in the background when we are engaged with fiction" (Lamarque, 1981, p. 302).

The literary scholar Frank Zipfel (2012) emphasized that humans do not exhibit emotions with respect to fictional contents but towards representations in general, which can comprise factual as well as fictional contents. Zipfel (2012, p. 136) suggests the distinguishing of two levels of consideration: (a) experienced vs. represented (or direct vs. indirect), and (b) real vs. fictive.

The capacity to develop emotion with regard to representations appears not to be uniquely human; it can also be observed in non-human primates. Mineka, Davidson, Cook, & Keir (1984; see also Cook & Mineka, 1989) presented rhesus monkeys that had been raised in a laboratory with a video showing wild-reared conspecifics exhibiting fearful reactions towards real snakes or snake models. The laboratory-raised rhesus monkeys acquired the fear of snakes from their observation of this representation. The capacity to learn from models in representations can be life-saving; in fact, it can be fatal to rely exclusively on one's own direct experience within a potentially dangerous environment.

As mentioned earlier, abstract language itself is not an object of emotion, but language can represent a state of affairs such as an action, event, or situation, which itself can be an object of emotion. Today, it is universally accepted that the extraction of meaning from language is embodied, meaning that semantic content activates the corresponding regions in the motor system (Gallese, 2007; Hauk, Johnsrude, & Pulvermüller, 2004; Pulvermüller, 2005; for an approach using naturalistic narrative material, see Wallentin, Nielsen, Vuust, Dohn, Roepstorff, & Lund, 2011). The second study examined in this thesis (reported on in Chapter 3) revealed the influence of the reception agreement (i.e., texts labeled either 'fact' or 'fiction') on the reader, suggesting a stronger action relevance for factual as compared to fictional texts. Are emotions, elicited by one and the same text, 'real' emotions when labeled as *fact* and 'quasi-emotions' when labeled as *fiction*? The answer to that question is highly dependent on the adduced emotion theory, and on whether it conceptualizes action or action tendency as the predetermined/constituent property of emotions (Frijda, 1986; Oatley & Jenkins, 1996).

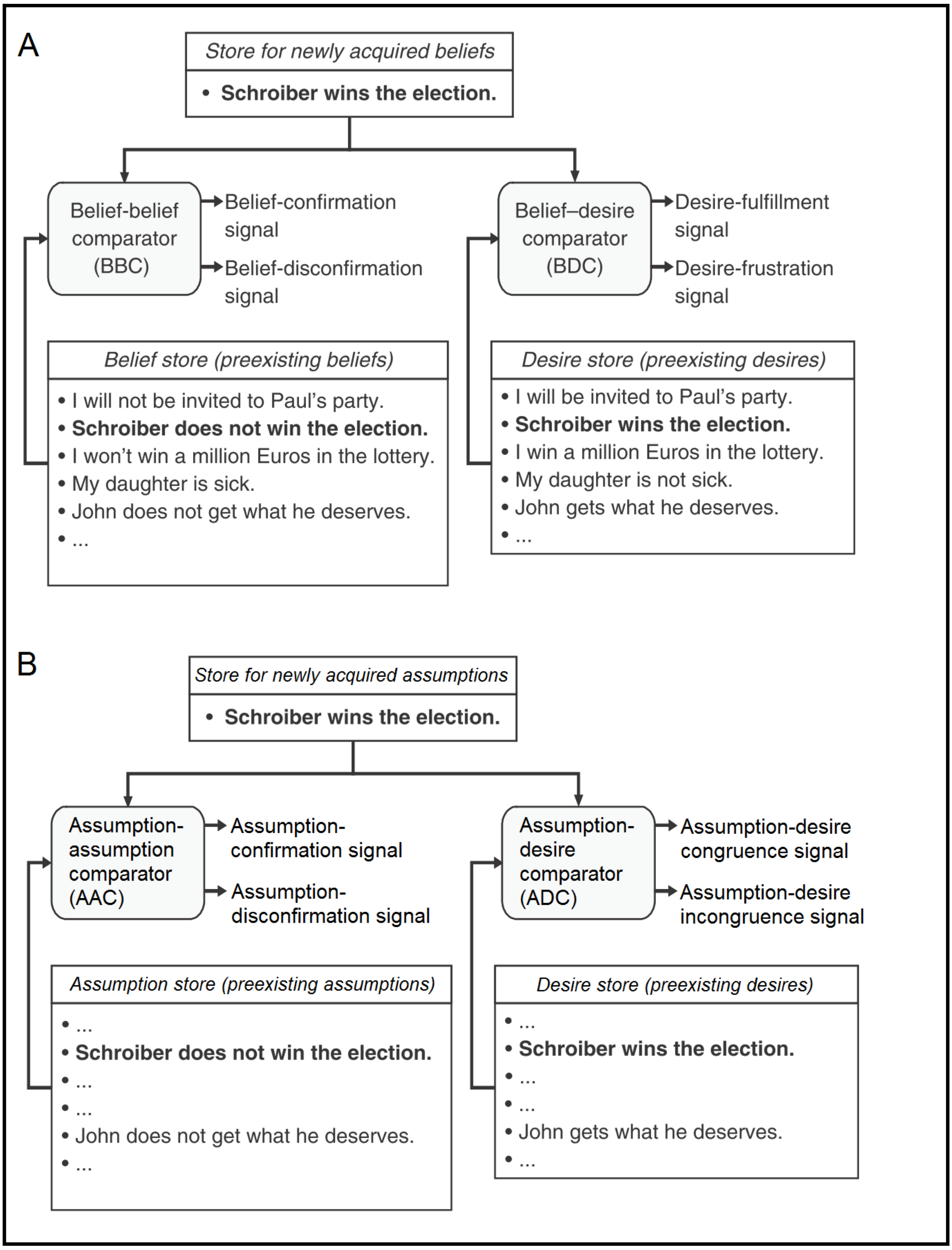


Figure 1.3. The belief desire theory of emotion (A), extended to fantasy emotions (B, adapted from Reisenzein, 2012).

One account is provided by Reisenzein (2012a, b), who extended his Computational Belief-Desire Theory of Emotion (CBDTE) explicitly to fantasy emotions (Figure 1.3). The CBDTE in its basic form assumes that emotions can be elicited on the basis of a belief (that something is the case) and a desire (that something should be the case) about a certain state of affairs. Emotions arise, according to the model, as a result of comparative analysis. The Belief-Belief Comparator (BBC) matches pre-existing beliefs with new ones, as a result of which actual beliefs can be modified. Similarly, the Belief-Desire Comparator (BDC) matches actual beliefs with actual desires, detecting (preconscious) congruence or incongruence between both.

With respect to the extension of the CBDTE model, Reisenzein refers to the philosopher and psychologist Meinong (1983/1910), who introduced the notion of 'fantasy emotions' in order to address the paradox of fiction. Meinong stated that fantasy emotions do not emerge from beliefs (which include belief in the existence of the object of the emotion), but from assumptions. Reisenzein (2012) extended the CBDTE model with an Assumption-Assumption Comparator (AAC) to account for the comparing of newly made assumptions with pre-existing assumptions; and an Assumption-Desire Comparator (ADC), for the matching of newly acquired assumptions with pre-existing desires. *Fantasy emotions* then emerge as a result of the comparison between new assumptions and pre-existing assumptions or desires. Are, then, *fantasy emotions* 'real' emotions, or quasi-emotions, according to the extended CBDTE? The model in its actual form remains open to both interpretations. On the one hand, the outcomes of the Belief-Desire Comparator be qualitatively different could from those of the Assumption-Desire Comparator. On the other, differences in the outcomes of the BDC and ADC might simply reflect differences in emotional intensity or timecourse, but not quality (see Reisenzein, 2012b for a broader discussion of this question). The latter interpretation would be in accordance with the *Panksepp-Jakobson hypothesis* described in section 1.1.3. (for empirical evidence, see Sperduti et al., 2016).

1.2. Conceptualization of the empirical studies

1.2.1. Chapter 2: The power of emotional valence

The first study was implemented in order to test the *fiction feeling hypothesis.* It was predicted that increasing negative story valence leads to similar activation patterns of affect-related brain regions as found in previous studies on single-word and sentence level. Moreover, the involvement of the affective ToM network was expected, as the negative valence of stories appears to be intertwined with the plights and conflicts the protagonists are confronted with.

1.2.2. Chapter 3: Fact vs Fiction

The second study tested the *simulation hypothesis* regarding the neuronal processing of texts, labeled either 'fact' or 'fiction', in combination with the *modulation-by-context hypothesis*, according to which the mere labeling of a text as fictional invites the reader to enter the game of pretence and simulation (German *et al.*, 2004; Whitehead *et al.*, 2009). This approach disregarded possible stylistic differences, thus keeping the lower route of the NCPM constant.

1.2.3. Development of the stimulus material for the study of the power of emotional valence and the Fact vs. Fiction study

Approaching the research questions described above, required the construction of suitable test material. To this end, 80 short narratives were used (mean number of words: 48, range: 41–57), adopting 40 of them a narrative-based game, the so called *black stories* (©moses Verlag GmbH, 47906 Kempen, www.moses-verlag.de). The plot of these stories was negative in valence (including crimes, disasters, and accidents) and comparable to the content of daily news stories, but also of novels or crime stories. For the other half of the material, we created 40 additional narratives that had comparable content settings but were neutral in valence. In these stories, protagonists were not confronted with plights pursuing their goals smoothly. Negative and neutral narratives were matched on the number of protagonists, sentences, words, and syllables, as well as on word frequency and comprehensibility. Two prestudies were applied: (1) Firstly, a prestudy with 32 participants (16 female, 16 male) was conducted in order to make sure that content and style of the text material included only events that could possibly occur, and that the micro-narratives could be read under two context-label conditions ('real', 'invented') which were used during the task in the MRI scanner. (2) Secondly, a group of 32 participants (16 female, mean age = 24.6; SD = 4.3) rated the text material on valence (“How do you perceive the text?”, scale from –3-“very negative” to 3-“very positive”) and liking (“Do you like the text?,” scale from 1-“I do not like it at all” to 7-“I like it very much”). The resulting mean rating values of each scale were then used in the first fMRI experiment (described in Chapter 2) to modulate parametric regressors for the effect of valence and liking during reading. (Please refer to Table 2.7 for further details on the second prestudy. A complete list of the final study material is provided in Appendix 1).

1.2.4. Chapter 4 - Beyond beauty

When readers get immersed into a narrative world, they are free to direct their attention throughout the reading process, e.g., to elements of foregrounding, and to adopt their speed of reading. Fiction feelings or aesthetic responses that emerge from the involvement with the narrative content thus result from a self-paced processing of the artwork. The fiction feeling hypothesis predicts that emotional contents invite readers to immerse and engage empathically with the protagonists of the represented narrative world. This raised the question whether representational art has a similar power to engage the beholder empathically. Although, several philosophers and psychologists emphasized mentalizing and empathic engagement to be crucial aspects of aesthetic experience (Lipps; 1903; see Currie, 2011; Freedberg & Gallese, 2007; Hirstein, 2013), especially the young discipline of neuroaesthetics focussed at gaining insight into the processing and explicit judgment of beauty throughout the past decade (Chatterjee, 2011; Chatterjee & Vartanian, 2014; Cela-Conde et al., 2004; Kawabata & Zeki, 2004; Vartanian & Goel, 2004).

Although disinterestedness has been frequently accentuated a crucial characteristic of aesthetic experience (Leder et al., 2004; Leder et al., 2014) such processes have rarely been examined in neuroscientific studies on visual aesthetics. The study reported in Chapter 4 aimed at testing the hypotheses that mentalizing and empathic engagement are more likely to unfold if participant's attention during art perception is not focused on an explicit judgment of liking and the respective decision they are requested to provide.

1.2.5. Development of stimulus material for the Beyond beauty-study

A set of 200 artworks was assembled and rated by non-experts for preference, abstractness, and familiarity in a prestudy (using scales from -3 to +3). In order to avoid potential memory effects only paintings relatively unfamiliar to the non-experts were selected. The final set consisted of 120 paintings representing a variety of artists (Marc Chagall, René Magritte, Édouard Manet, Claude Monet, Rembrandt van Rijn, Pierre-Auguste Renoir, Vincent van Gogh, and Jan Vermeer) and artistic styles (baroque, impressionism, expressionism, and surrealism). The artworks included paintings depicting one or more human subjects with clearly recognizable faces (49%), paintings depicting figures but no clearly recognizable faces (27%) or figures subtly in the background (13%), as well as landscapes or still lifes (19%). A complete list of the final set of artworks is available from the authors on request..

1.2.6 Components of Theory of Mind (ToM)

All studies upon which this dissertation has focused refer to the concept of theory of mind (ToM). The literature distinguishes two components of ToM: *cognitive ToM* and *affective ToM* (Figure 1.4; see Walter, 2012 for a review). Cognitive ToM refers to mental state attribution in general (goals, intentions and desires of others) and engages a network comprising the dmPFC, STS, and TPJ. Affective ToM can be used almost synonymously with *cognitive empathy* and relates to the capacity to understand another's affective state.

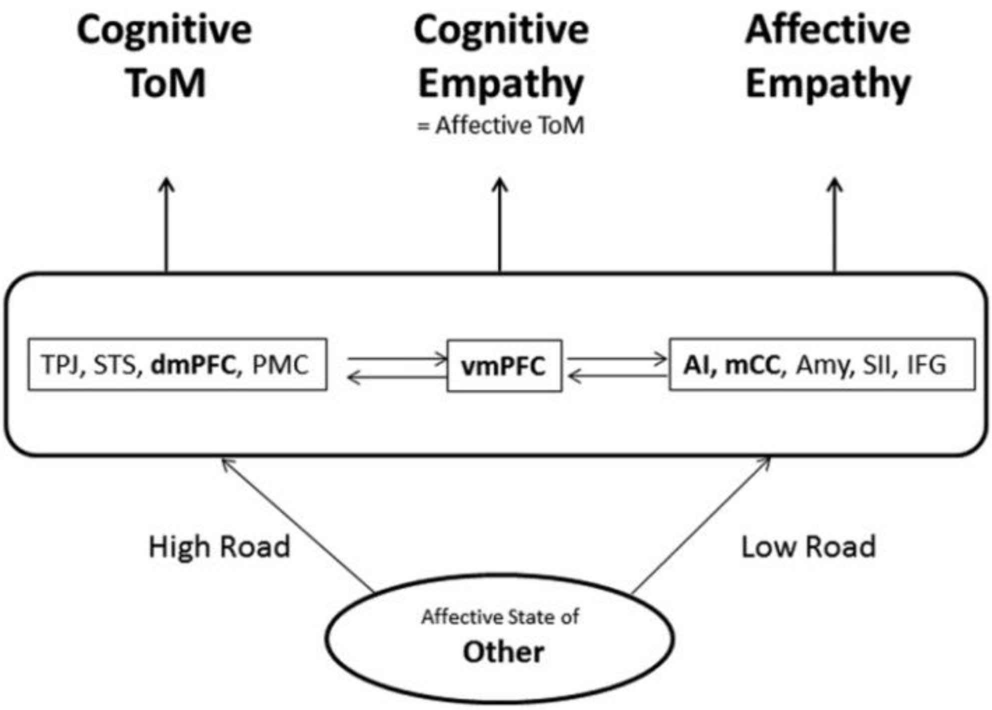


Figure 1.4. Brain circuits for empathy and theory of mind (ToM). The affective state of another can elicit activations in the observer either by bottom–up affective signals ("low road") or by top–down cognitive information on content and context ("high road"). The large rectangle depicts schematically the brain of the observing self and the small rectangles depict neural networks that have some specificity for the types of mental processes in the upper part. However, as indicated by the arrows between the small rectangles, these systems can be coactivated, as, for example, shown by the recruitment of the cognitive ToM system in cue-based elicitation of empathy for pain. (Figure and description taken from Walter, 2012).

Chapter 2.

The power of emotional valence – from cognitive to affective processes in reading

This chapter was published as

Altmann, U., Bohrn, I. C., Lubrich, O., Menninghaus, W., & Jacobs, A. M. (2012). The power of emotional valence—from cognitive to affective processes in reading. *Frontiers in Human Neuroscience*, *6*, 192. http://doi.org/10.3389/fnhum.2012.00192

2.1. Introduction

Humans are storytellers. They share daily experiences, tell each other anecdotes, and exchange gossip (Baumeister et al., 2004; Dunbar, 2004). Besides producing and performing live narratives (McAdams Dan, 2001; Habermas and de Silveira, 2008), individuals also extensively consume stories: we read them in newspapers and magazines, in biographies and novels, via videotext or on the internet (for the purpose of this paper, we will use the term story in a broad sense synonymous with narrative). Yet even when stories have a negative content, as they deal with conflicts or crises, individuals not only understand, but also appreciate or enjoy them. In a study by Berthoz et al. (2002), for example, stories with endings that were either embarrassing or violated social norms were rated as funnier compared to stories whose endings reaffirmed normative social behavior.

We have, however, only limited knowledge about the neural processing of the emotional valence of stories. On the one hand, research on the neural effects of valence focuses primarily on the level of single words (Kuchinke et al., 2005; see Citron, 2012 for a review) or sentences (Willems et al., 2010; Kuchinke et al., 2011). On the other hand, there is extensive literature on the cognitive and emotional neural processing underlying theory of mind (ToM) stories (Abu-Akel and Shamay-Tsoory, 2011; Brink et al., 2011; Schnell et al., 2011; Walter, 2012). In these studies, individuals are often asked to make explicit cognitive and affective attributions to auditory or visually presented stories, and the material is primarily selected for its capacity to invoke mental state attributions. What has not been investigated so far is the question to what extent the emotional valence of such stories might contribute to ToM related neural processes. Usually, no data concerning the valence of ToM stories were included in the analysis or reported as a selection criterion (but see Berthoz et al., 2002; Brink et al., 2011). In the current study, we therefore took a reversed approach and investigated the contribution of emotionally valenced story contents to ToM-related processing in a passive reading task. In particular, we were interested in whether increasing negative story valence would engage not only more brain regions related to affective processing, but also invite a stronger engagement of ToM-related regions. Story comprehension seems to be closely linked to ToM, as it presupposes the understanding of actions and intentions of real or invented protagonists (Ferstl et al., 2008).

In a recent meta-analysis, Mar (2011) reported a profound overlap between text-based ToM studies and non-text-based ToM studies that used cartoons, pictures, animations or games as stimuli. Common activations comprised the dorsomedial prefrontal cortex (dmPFC), bilateral posterior superior temporal sulcus (pSTS), right temporoparietal junction (TPJ), left inferior frontal gyrus (IFG), bilateral medial temporal gyrus (MTG), and anterior STS. Moreover, the analysis revealed large overlaps between the ToM network and results from studies that primarily investigated comprehension of texts with a narrative structure rather than ToM.

The literature distinguishes two components of ToM: *cognitive ToM* and *affective ToM* (see Walter, 2012 for a recent review). Cognitive ToM refers to mental state attribution in general (goals, intentions and desires of others) and engages a network comprising the dmPFC, STS, and TPJ, as reflected in the meta-study by Mar (2011). Affective ToM can be used almost synonymously with *cognitive empathy* and relates to the capacity to understand another's affective state. Although the actual experience of a corresponding affective state is explicitly not assumed within the framework of this concept, recent data suggest an interplay of cognitive and affective processes (Schnell et al., 2011).

The first aim of the current study was to investigate the interplay of negative story content and ToM. We used a set of short narrative texts that were either neutral or negative in valence. The neutral stories deal with everyday events and actions. They meet the definition of prototypical third-person narratives as they “have a telic structure including an agent, a goal and a causal sequence connecting the agent's various actions with the achievement or nonachievement of the goal.” (Hogan, 2003, p. 205). According to Bruner (1986, p. 35), good “storytelling, inevitably, is about compelling human plights that are “accessible” to readers.” (Bruner, 1986, p. 35). “Access” to a story presupposes the comprehension of actions, intentions and goals of its protagonists, and should thus be closely linked with ToM processes (Mason and

Just, 2009; Mar, 2011). We therefore assume that, compared to their neutral counterparts, the negative stories we used were more effective in their potential to engage ToM, as their negative valence is related to the above mentioned “plights”.

For the understanding of affective processes in reading, the consideration of valence might be one aspect to consider. The issue of liking could be another one. Highly interesting artwork can be disturbing and unpleasant (Turner and Silvia, 2006), and it has been known since Aristotle's work on tragedy that narrative contents do not have to be pleasurable in the sense of positive valence in order to be liked. The second aim of the current study was to investigate the neural substrate of liking negatively valenced narratives. This at first glance paradoxical tendency to like and enjoy unpleasant contents has been investigated in media psychology regarding different narrative contexts, including tragic television news and crime drama (Zillmann et al., 1998; Raney, 2002; Raney and Bryant, 2002). The enjoyment of unpleasant stories is not limited to a positive ending; in fact, a film without happy-end can also be enjoyed (Schramm and Wirth, 2010). How can liking unpleasant stories be explained? Disposition-based theories (Zillmann, 1994) postulate the involvement of two key factors: empathy with the character and moral evaluation. Accordingly, the enjoyment of unpleasant stories depends on the affective disposition and empathic reactions towards the characters as well as on moral judgments of the outcomes the characters were confronted with (deserved/undeserved). Correspondingly, increased sad film enjoyment was reported for viewers with high empathy (de Wied et al., 1994). In a study on crime drama, Raney (2002) found that (a) the enjoyment of unpleasant contents was predicted by moral judgments and that (b) moral judgments were predicted by empathy. Parkinson and colleagues (2011) investigated the neural processing during moral judgments of stories containing harm, dishonesty, or disgust. The dmPFC was the only region that all scenarios had in common and that therefore might represents a general underlying evaluative processing. Together, these studies led us to the following assumptions: (1) If moral judgment is associated with the enjoyment of unpleasant stories, as reported for crime drama by Raney (2002), the dmPFC might be especially involved when negatively valenced (unpleasant) narratives are simultaneously liked. (2) If moral judgments of narratives are related to empathy, coactivation of empathy-related brain regions and dmPFC can be expected.

Growing evidence suggests that reading (especially reading fiction) has the capacity to modify personality traits (Djikic et al., 2009) and is associated with better performance on scales of empathy and social abilities (Mar et al., 2006). Therefore, further insight in the affective processes in reading can help to inform us about their contribution to ToM-related processes and their potential capacity to enhance ToM development.

To sum up, we hypothesized that (1) passive reading and comprehension of both stories with neutral and negative valence should engage the cognitive ToM network. (2) We further predicted that increasing negative story valence leads to (a) similar activation patterns of affect-related brain regions as found in previous studies on single-word and sentence level. Moreover, we expected to find (b) the affective ToM network to be involved, as the negative valence is intertwined with the plights and conflicts the protagonists are confronted with. Neutral narratives should invite less ToM processes because the protagonists (and along with them the reader) can follow their goals and intentions without major disturbances or complications. (3) We expected to find an interaction effect of negative valence and liking. In detail, reading stories that are considered negative but simultaneously liked should especially engage the mPFC, reflecting the moral monitoring of the characters and the plights they have to deal with. (a) This region should show a functional coupling with brain areas related to ToM and affective processing.

2.2. Methods

2.2.1. Material

We used 80 short narratives (mean number of words: 48, range: 41–57), adopting half of them from the so called *black stories*, a narrative-based game (©moses Verlag GmbH, 47906 Kempen, www.moses-verlag.de). The plot of these stories was negatively valenced (crimes, disasters, accidents), comparable to the content of daily news stories, but also of novels or crime stories. For the other half of the material, we created 40 additional narratives that had comparable content settings but were neutral in valence. In these stories, protagonists pursued their goals smoothly and were not confronted with plights. Negative and neutral narratives were matched on the number of protagonists, sentences, words, and syllables, as well as on word frequency and comprehensibility. We conducted a prestudy with 32 participants (16 female, 16 male) in order to make sure that content and style of the negative and the neutral narratives included only events that could possibly occur, and that they could be read under two context-label conditions ("real," "invented") which were used during the task in the MRI scanner. A second group of 32 participants (16 female, mean age = 24.6; SD = 4.3) rated the material on valence ("How do you perceive the text?", scale from −3-"very negative" to 3-"very positive") and liking ("Do you like the text?," scale from 1-"I do not like it at all" to 7-"I like it very much"). The resulting mean rating values of each scale were then used in the fMRI experiment to modulate parametric regressors for the effect of valence and liking during reading (please refer to Table 2.7 for further details on the prestudy).

2.2.2. Participants

Twenty-four healthy, right-handed volunteers (12 female, mean age = 26.5; SD = 6.7) took part in the study. Participants were German native speakers and skilled readers (assessed with a screening test that provides normdata for adults; SLS—Salzburger Lesescreening, unpublished version). Only participants who did not know the game *black stories* and were naive to its content were included. All participants had normal or corrected-to-normal vision and gave informed written consent in accordance with the local research ethics committee.

2.2.3. Task

A 2 × 2 repeated measures design was applied with one factor varying the story-type ("negative," "neutral") and a second factor varying the context in which a story was presented ("real," "invented"). 20 stories were shown in each factor combination

(Figure 2.1). We pseudo-randomized the order of conditions as well as the presentation of the narratives across conditions, but all participants read exactly the same set of black stories and neutral narratives. During the fMRI experiment, a narrative was presented for 20 s, displayed on five lines (shown 4 s each). Prior to the story, a context label (either "Real" or "Invented") was presented for 3 s. Participants were requested to read the text silently and solve a verification task following each text. By means of a cue ("Real?" or "Invented?") participants were either asked, as an attention control task, whether the story they just read was real, or they were asked whether it was invented. Participants answered by pressing a button ("yes," "no"). The verification cues were presented in a pseudorandomized order to avoid motor preparation during the reading phase and to assure an equal assignment of question cues and required responses with regard to each condition. Additionally, participants completed the Interpersonal Reactivity Index (IRI; Davis, 1983; German version: Paulus, 2009), which provides a four-dimensional self-report estimate of empathy. In this study, we focus on the "empathic concern" subscale, which assesses the individual tendency to feel concern and compassion for other people, because empathic concern was found to be associated with increased interest in tragic television news (Hoffner et al., 2009) as well as with the perception of a liked partner being in pain (Singer et al., 2004). Empathic concern scores showed a mean of 13.09 and a standard deviation of 1.79 (corresponding mean of German population norms = 14.56, SD = 2.94; norm data retrieved from Paulus, C., "Normtabellen des SPF," last modified November 21, 2011, http://bildungswissenschaften.uni-saarland.de/personal/paulus/empathy/Normen.pdf).

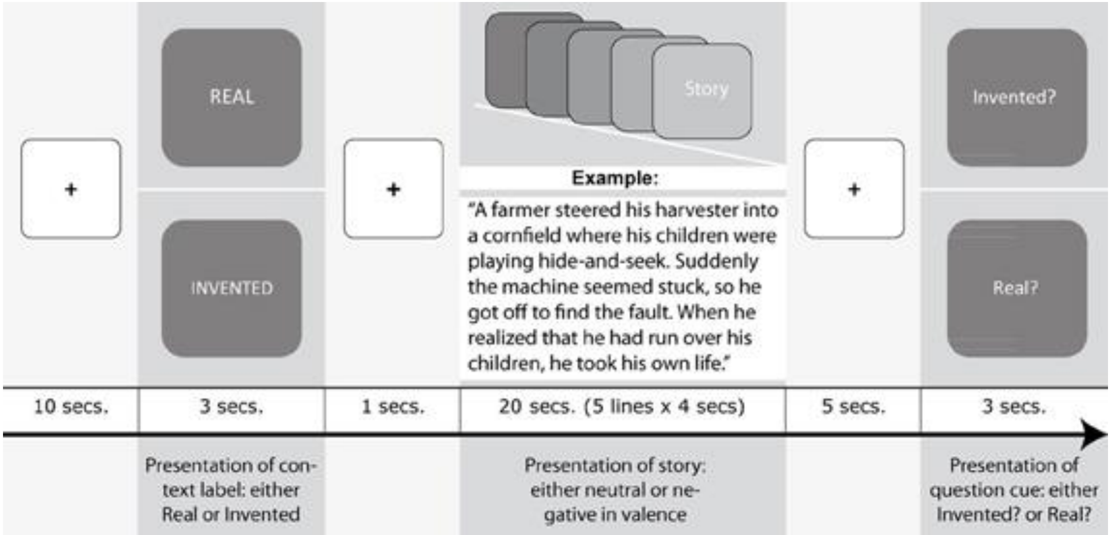


Figure 2.1. Experimental design and stimuli**.**

2.2.4. fMRI data acquisition

Functional data were acquired on a Siemens Tim Trio 3 T MR imager at 3 T field strength. Four runs of 425 volumes were measured using a T2* weighted echo-planar sequence [slice thickness, 3 mm; no gap; 37 slices; repetition time (TR), 2 s; echo time (TE), 30 ms; flip angle, 90°; matrix, 64 × 64; field of view (FOV), 192 mm; voxel-size 3.0 × 3.0 × 3.0 mm], and individual high-resolution T1-weighted anatomical data (MPRAGE sequence) were acquired (176 slices; FOV, 256; TE, 2.52; TR, 1.9; matrix, 256 × 256; resolution 1.0 × 1.0 × 1.0 mm; sagittal plane; slice thickness, 1 mm).

2.2.5. Data analysis

Analysis of fMRI data was conducted with Brain Voyager QX [2.0] (Brain Innovation, Maastricht, Netherlands; Goebel et al., 2006). Functional Data were corrected for head-motion and for different slice scan times using cubic spline interpolation. To remove low-frequency signal drifts, a high-pass filter was applied with a cutoff period three times the block length. Spatial smoothing was performed using a Gaussian filter of 8 mm, full width at half maximum. The functional maps of each participant were then transformed into standard Talairach space (Talairach and Tournoux, 1988).

Whole-brain statistical analysis was performed according to the general linear model as implemented in Brain Voyager QX. On the first level, the model was generated with two blocked regressors for the reading of stories (negative, neutral) and two blocked regressors for the instruction and attention task periods. Three different models were constructed: (1) the first model included an additional parametric regressor containing the mean valence for each story/narrative, (2) the second model was added by a parametric regressor containing the mean liking values for each story/narrative (3) and in the third model we added the parametric interaction term of valence and liking (valence × liking). For each model, individual contrast images from the first level analysis were then applied to a second level random effects group analysis, in which we tested for the parametric effects of (1) reading negatively valenced stories (2) liking of texts, and (3) the corresponding interaction (valence × liking). All parametric contrasts were reported whole brain corrected ($p < 0.05$) using false discovery rate (FDR), and with an extend threshold of $k = 20$ voxels for the resulting clusters.

In correspondence with our initial hypotheses, we identified the mPFC as involved in the interaction of negative valence × liking and selected it as the seed region for further psychophysiological interaction (PPI) analysis (Friston et al., 1997) with a sphere of 10 mm around the peak voxel (−9, 41, 16). PPI analysis provides a measure for task related functional connectivity—it allows identifying brain regions that show a stronger co-activation during one task (reading negative stories) as compared to another (reading neutral stories). Particularly we were interested in whether valence-specific mPFC activation (i.e., reading negative stories) is “coupled” with emotion and ToM-related brain areas, especially the temporal poles (TP), the IFG, and the temporoparietal junction (TPJ). The PPI regressor was calculated as the element-by-element product of the mean corrected mPFC region of interest, and the task vector coding for the valence-specific effect of reading black stories compared to reading neutral narratives. To identify areas of the brain that showed increased activity while reading black stories when mPFC activity increased, individual PPI regressors where entered into a second level random effects analysis [reported whole brain corrected ($p < 0.05$) using FDR, $k = 20$ voxels]. Finally, we repeated the analysis with individual scores on the empathic concern scale of the IRI as covariate to examine areas of the brain that showed a stronger coupling with mPFC depending on the individual tendency to feel concern for other people [cluster level corrected ($p < 0.05$) using Monte Carlo simulations as implemented in Brain Voyager, initial voxel level threshold $p < 0.001$ uncorrected].

2.3. Results

2.3.1. Conjunction of negative and neutral narratives

Prior to the analysis that focused on emotional valence, we applied a conjunction analysis in order to assess the common effects of neutral and negative narratives (Table 2.1 and Figure 2.2A). This analysis revealed that neutral and negative narratives share extensive activation patterns including brain areas that are regularly reported for cognitive ToM, namely the dmPFC (BA 9), bilateral TP (TP: BA 38), and posterior superior temporal gyrus (pSTG: BA 22/39).

2.3.2. Parametric effects

First, we analyzed the parametric effect of negative valence (Table 2.2 and Figure 2.2B). This led to subcortical activations in the left striatum (caudate body), left mediodorsal thalamus, and left amygdala. Furthermore, the analyses revealed an extensive fronto-temporal network including the left mPFC (mPFC: BA 8/9), the bilateral IFG (IFG: BA 45/47), and the TP (TP: BA 38), the left fusiform/parahippocampal gyrus (BA 20/36), the bilateral middle temporal gyrus (MTG: BA 21) and STG (BA 22), as well as the bilateral posterior superior temporal gyrus extending to the temporal parietal junction (STG/TPJ: BA 39).

Second, we analyzed the parametric effect of liking (Table 2.3). Activations were found in the bilateral anterior STG/TP (BA 38), anterior MTG (BA 21), IFG (IFG: BA 45/47), lingual/fusiform gyrus (BA 18/19), and left posterior cingulate cortex (PCC: BA 30).

Third, we analyzed the parametric interaction effect of valence and liking (Table 2.4 and Figure 2.2C). Increasing negative valence combined with increasing values of liking was associated with activations in the bilateral mPFC (BA 9, 32), supramarginal gyrus/TPJ (BA 39/40), and left dorsolateral prefrontal cortex (DLPFC: BA 8).

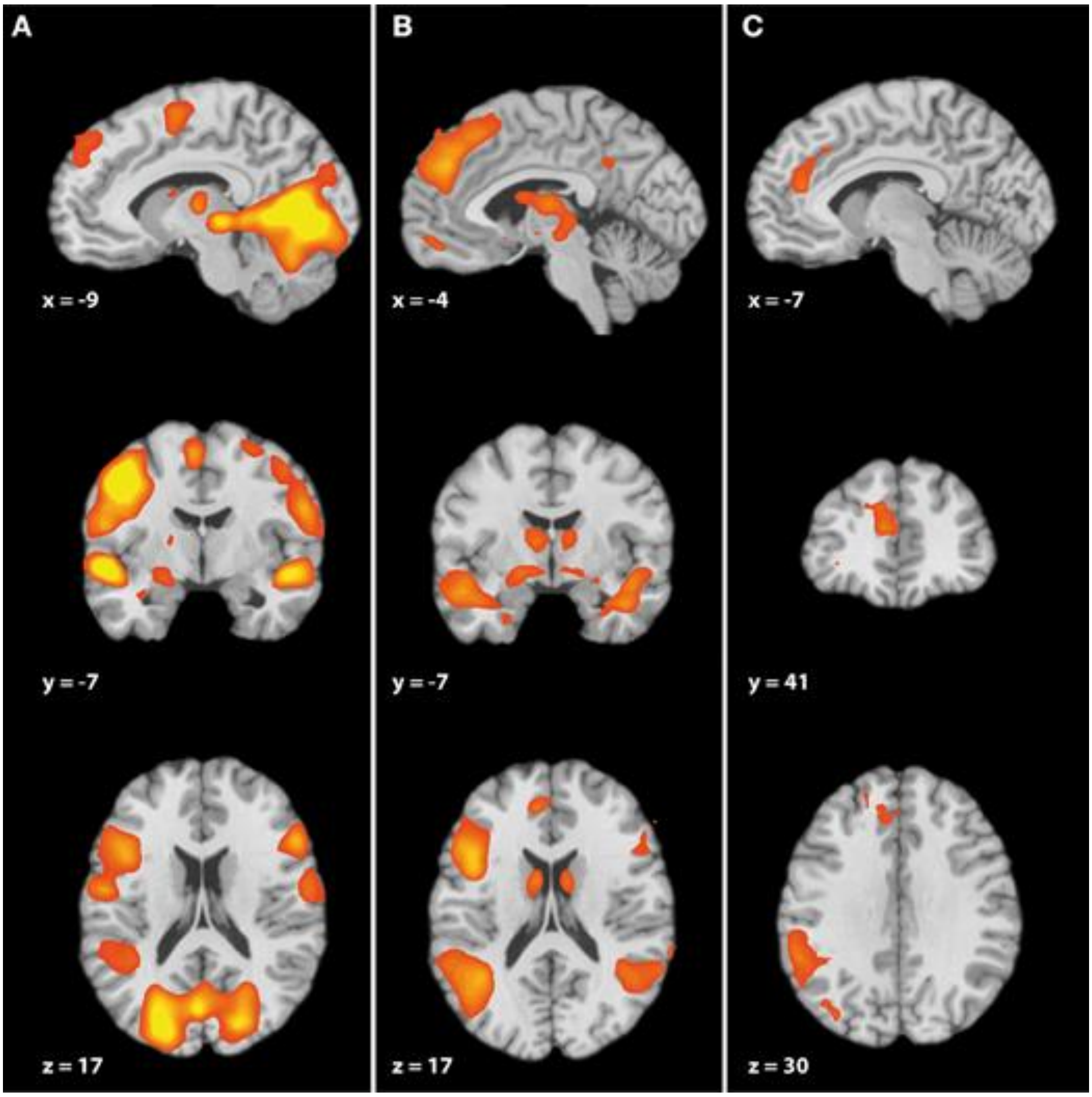


Figure 2.2. (A) Brain activation for story reading — conjunction of negative stories and neutral stories **(B)** Parametric effect of increasing negative valence **(C)** Brain activation for increasing negative story valence combined with increasing story liking—Parametric interaction of valence × linking, whole brain corrected ($p < 0.05$) using FDR.

2.3.3. PPI analysis

Next, we examined the results of the PPI analysis with the mPFC as the seed region, as this region revealed an interaction effect of valence × liking (Table 2.5 and Figure 2.3). Several regions showed a stronger coactivation with the mPFC during the reading of the negatively valenced stories as compared to the neutral narratives (negative > neutral). Such coactivations could be observed bilaterally in the IGF extending into the insula (BA 45/47/13), the thalamus, the supramarginal gyrus (BA 40), and the vmPFC (BA 10) as well as in the left amygdala, the right dorsal striatum and the dorsal ACC (BA 32).

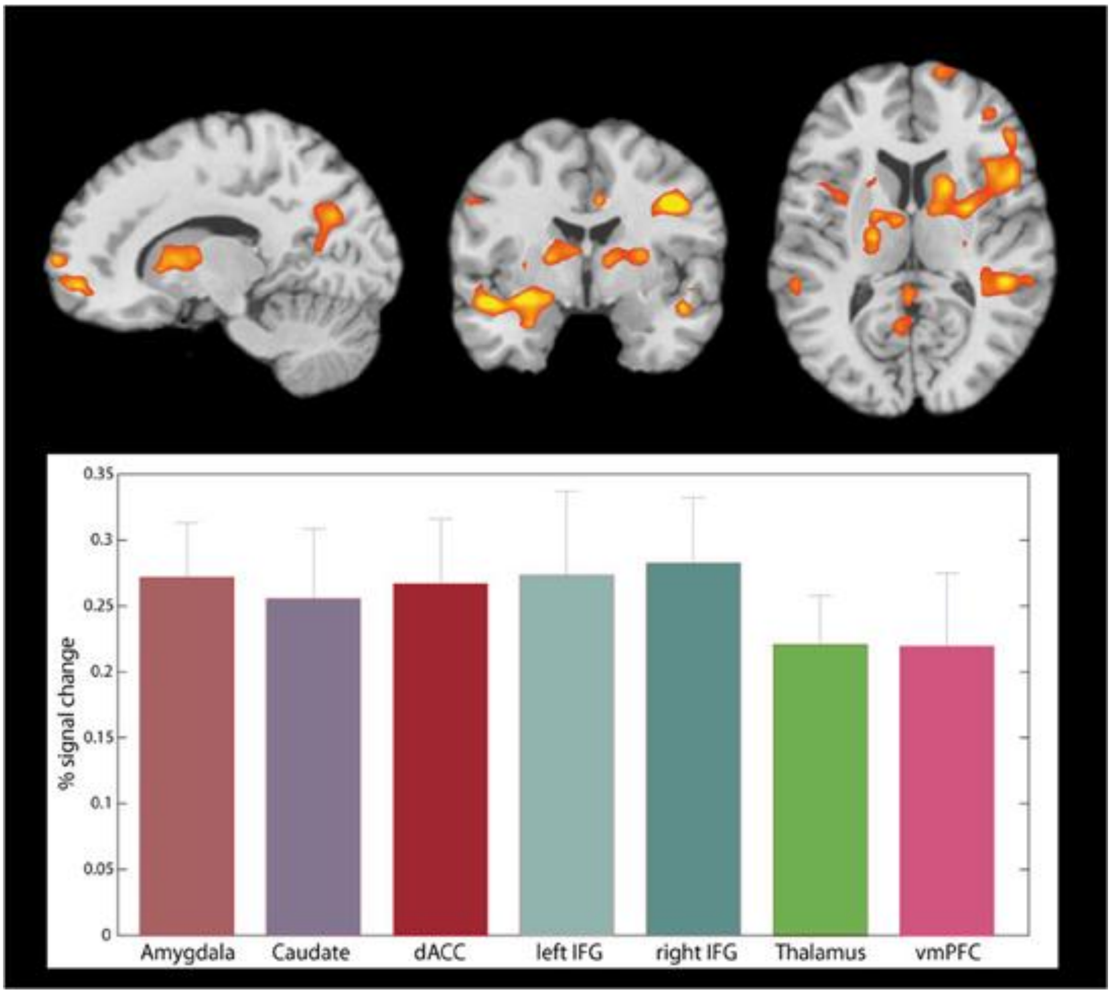


Figure 2.3. Brain regions showing positive connectivity with mPFC while reading negative stories compared to reading neutral stories, whole brain corrected ($p < 0.05$) using FDR.

An additional PPI analysis was applied to take the individual tendency to feel concern for other people into account. It was tested which areas of the brain showed higher functional connectivity with mPFC during reading negative stories, depending on self-report scores at the empathic concern scale. The bilateral anterior insula (BA 13) and the right posterior cingulate cortex (BA 31) (Table 2.6 and Figure 2.4) showed a stronger coupling with mPFC for individuals who reported a stronger tendency to feel concern for other people [cluster level corrected ($p < 0.05$), initial voxel level threshold $p < 0.001$ uncorrected].

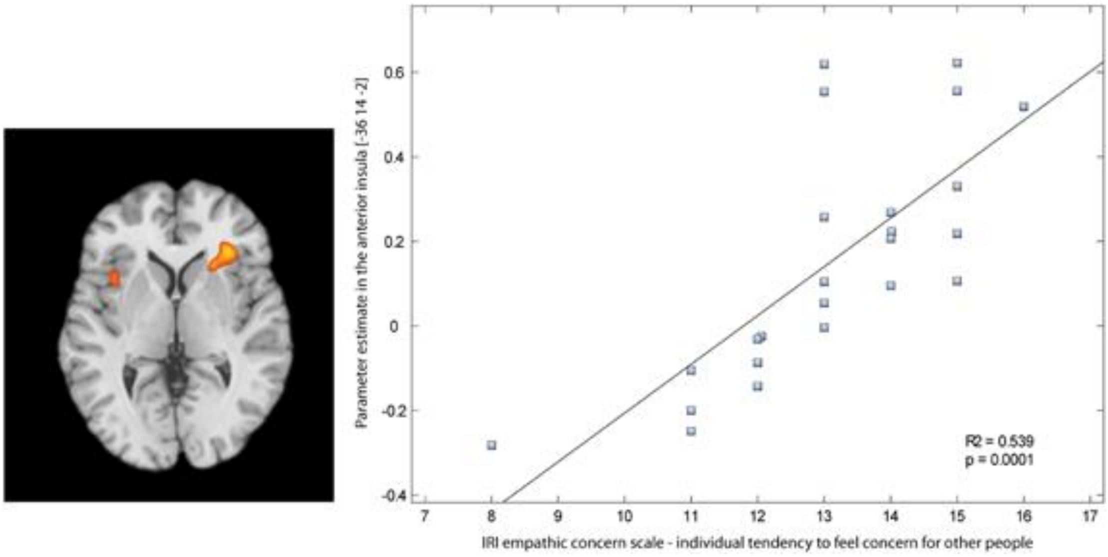


Figure 2.4. Positive connectivity between mPFC and the anterior insula correlates with the individual tendency to feel concern for other people (Positive correlation between the empathic concern scale and mPFC–connectivity while reading negative stories compared to reading neutral stories), cluster level corrected ($p < 0.05$), initial voxel level threshold $p < 0.001$ uncorrected.

2.4. Discussion

2.4.1. The interplay of story valence and ToM

This study aimed to investigate the hypothesis that narratives with negatively valenced content invite for an increased engagement of the affective mentalizing network (cognitive empathy). The conjunction analysis between neutral and negatively valenced narratives showed that they share the cognitive ToM network, including dmPFC, bilateral TP, and left pSTS.

As hypothesized, these regions became more engaged with increasing negative valence. The parametric analysis of valence revealed activations in the bilateral posterior STS/TPJ and the anterior subdivision of the mentalizing network, comprising dmPFC, TP, and aSTS/MTG. This network appears to be especially involved when mental state reasoning requires the interplay of cognitive and affective components (cognitive empathy; Preston and de Waal, 2002), e.g., for the inference of another person's affective state. In a recent study, Schnell and colleagues (Schnell et al., 2011) investigated cognitive empathy and found a simultaneous activation of the anterior mentalizing network and limbic structures, including the left amygdala, when affective as compared to non-affective visuospatial states had to be inferred. This network could also be observed when the participants made affective judgments about social contexts from their own point of view, without being explicitly asked to adopt a third-person perspective. This fits the requirements of the task used in the current experiment, as our participants were asked simply to read the short narratives.

In line with those previous findings our results suggest a close link between affective and cognitive components for mentalizing. Two key areas of cognitive ToM, the dmPFC and the TPJ, were also related to valence. Particularly, the dmPFC and the TPJ region seem to increase activation when updates of character-related information and the processing of intentions are needed (Saxe and Wexler, 2005; Mason and Just, 2009). In a study of Hooker and colleagues (Hooker et al., 2008), participants had to infer the emotional responses of characters in social scenes. In order to predict correctly whether an emotional response of a character might change or remain constant participants had to update their character-related information. In line with our results, the engagement of regions associated with mentalizing (STS/TPJ, mPFC, TP) and with emotion (IFG, thalamus) was higher when the emotions of a character were likely to change and unlikely to remain constant.

These observations are compatible with the negative stories in the current study: here, the intentions and emotions of the characters often changed as they were confronted with several "plights" (Bruner, 1986). In the neutral stories, on the other hand, the characters could act upon their goals without major disturbances. Apparently, the conflicts implicated in the negative stories evoke more attributions of goals and thoughts to the characters, as opposed to the neutral, everyday stories. Such attributions and inferences are essential for understanding the character and the story at large. And with increasingly negative emotional valence, reading stories also engaged the bilateral IFG and additional subcortical structures commonly involved in emotion processing, namely the bilateral dorsal striatum (caudate body), left mediodorsal thalamus, and left amygdala.

The thalamus appears to be involved in general emotion processing, independent of valence (Lane et al., 1997; Goldin et al., 2005) or social/nonsocial content (Britton et al., 2006) and has been shown to be involved when subjects empathize with a protagonist suffering a threat (emotional empathy) compared to empathizing with a protagonist in a neutral everyday (cognitive empathy) situation (Nummenmaa et al., 2008). Engagement of the amygdala has been reported for viewing pictures of negative emotion (Lane et al., 1997) and watching sad films (Goldin et al., 2005), but, similar to the thalamus, this structure is presumably more sensitive to the salience than to the valence of affective stimuli (Phan et al., 2004; Britton et al., 2006).

In correspondence with our results, a recent meta analysis (Mar, 2011) identified lefthemispheric amygdala activation to be associated with story-based ToM, whereas righthemispheric activation was found for nonstory-based ToM.

The IFG, which showed to be responsive to both emotional valence and liking in the present study, is considered a possible human analogue to the mirror neuron system (Rizzolatti and Craighero, 2004; Iacoboni, 2009). It was reported for the imitation and observation of emotion in pictures (Carr et al., 2003), imagery of emotional scripts (Sabatinelli et al., 2006), and might also play a role in affective mentalizing (Schnell et al., 2011). In correspondence with our results, Hynes et al. (2006) observed the orbital part of the bilateral IFG (BA 47) and the left IFG (BA 11) to be more strongly engaged in emotional perspective taking than in cognitive perspective taking in a story-based mentalizing task. Furthermore, potential mirror neuron activation in bilateral IFG and STS was found to correlate with empathy scores (Schulte-Rüther et al., 2007).

2.4.2. Liking of unpleasant story contents

The parametric interaction analysis showed that when valence and liking come together, the activation peak of the mPFC moves inferiorly and closer to the anterior cingulate gyrus (−9, 41, 16), compared to the activation peak resulting from the parametric valence effect alone (−6, 44, 31). For reading negatively valenced narratives (as compared to neutral ones) this region showed a functional coupling not only with regions related to ToM, but also with regions known to be involved in affective empathy (amygdala, anterior insula, midcingulate cortex, and IFG; Walter, 2012). These results were supported by the additional result showing a stronger functional coupling between the mPFC seed region and bilateral anterior insula engagement when the magnitude of the participant's empathic concern is taken into account. Similar correlations between the anterior insula and self-reported empathy have been observed for empathy of social pain (Masten et al., 2011), and for the observation of other individuals receiving pain (Singer et al., 2004, 2006).

These results support our initial hypotheses derived from media psychology, which assumed that moral evaluations and empathic reactions to characters in stories influence liking of unpleasant story contents (Raney, 2002; Parkinson et al., 2011). Further studies will be needed to systematically investigate the potential role of moral reasoning and its relationship to empathy for affective and aesthetic processes in reading. Empathy and moral reasoning about characters provide two possible factors which influence enjoyment in reading. Others are very likely involved as well, for instance stylistic features (Miall and Kuiken, 1994; Jacobs, 2011) and provided details (see Green et al., 2004 for an overview). A major challenge for future research will be the implementation of paradigms that allow us to follow the temporal dynamics of reading, particularly of longer, well-crafted stories. As Green and Brock (2000) showed, well-crafted, canonical stories were rated as more immersive. First steps in that direction have already been made (e.g., Wallentin et al., 2011).

2.4.3. Limitations of the study

The values for valence and liking that were used for the parametric analysis of the fMRI study reflect mean data that were derived from a prestudy and as such treated as characteristics of the stories. The fact that we did not use individual subject ratings of the fMRI sample might limit the conclusions that can be drawn from the results.

We decided for an implicit reading task as it was one purpose of the study to assess the interplay of valence, liking and ToM during (as much as possible) natural reading of stories. Post scan data of individual subjects for valence and liking might have strengthened the results. On the other hand, the usage of pretest data allowed preventing subjects from fatigue effects, likely arising for rating the 80 stories again during an additional postscan session. Moreover, it has been shown that especially liking judgments can change with repeated exposure (Tan et al., 2006), which might have distorted our data. The standard deviations for liking judgments were comparable to those of valence (Table 2.7). Thus, it could be excluded that the evaluation of liking implies lower intersubject agreement than the evaluation of valence. Similar observations have been made for judging the attractiveness of faces (for an overview see Chatterjee et al., 2009) and for reading poems (Martindale and Dailey, 1995). Given these potential limitations, we consider a similar study using postscan rating data desirable as to further inform us about individual effects in the reader and to strengthen the present results.

2.5. Conclusion

To summarize, taking the emotional valence (from neutral to negative) of the content of stories into account reveals the full scale of ToM-related processing, ranging from cognitive and affective ToM to components of affective empathy through top-down processing during reading (Walter, 2012). Therefore, it seems worthwhile to include valence for the investigation of ToM and related processes either as a variable of interest or as control variable (e.g., between conditions of interest and control conditions). Given the extensive use of stories in our daily life, their capacity to provide simulations of the social world (Mar and Oatley, 2008), and to evoke even emotional reactions as complex as liking unpleasant contents, we should attempt to improve our understanding of the underlying mechanisms and of how these processes might relate to learning and development.

Table 2.1. Brain activation for story reading (negative stories AND neutral stories)**.**

Cluster size	Region	BA		Talairach coordinates			Max. *t*-value
				X	*Y*	*Z*	
820	Inferior Frontal Gyrus	9	R	54.0	20.0	22.0	6.396.391
	Postcentral Gyrus	3	R	60.0	−10.0	25.0	6.249.121
	Precentral Gyrus	4	R	48.0	−13.0	52.0	5.192.021
	Middle Frontal Gyrus	6	R	27.0	−13.0	61.0	4.339.577
	Precentral Gyrus	6	R	39.0	−1.0	31.0	3.511.845
954	Middle Temporal Gyrus	21	R	48.0	−10.0	−11.0	9.289.865
	Superior Temporal Gyrus	38	R	48.0	11.0	−14.0	8.176.331
	posterior Insula	13	R	42.0	−19.0	−8.0	7.638.433
	Superior Temporal Gyrus extending into posterior Superior Temporal Gyrus	22	R	42.0	−28.0	−2.0	6.806.289
	Superior Temporal Gyrus	38	R	33.0	26.0	−29.0	4.523.798
	Middle Frontal Gyrus	11/47	R	27.0	38.0	−17.0	4.029.813
10940	Lingual Gyrus	18	R	12.0	−79.0	−5.0	41.358.112
	Lingual Gyrus	18	L	−12.0	−79.0	−5.0	21.272.240
	Lingual Gyrus	17	L	−21.0	−91.0	−2.0	19.262.949
	Cerebellum	*	L	−27.0	−73.0	−14.0	16.760.603
	Precentral Gyrus	4	L	−48.0	−7.0	43.0	13.336.107
	Fusiform Gyrus	37	L	−39.0	−61.0	−14.0	13.138.165
	Cuneus	17	L	−24.0	−82.0	13.0	12.455.202
	Superior Temporal Gyrus extending into into posterior Superior Temporal Gyrus	22	L	−54.0	−25.0	1.0	11.726.843
	Middle Temporal Gyrus	21	L	−57.0	−10.0	−5.0	11.552.003
	Superior Temporal Gyrus	38	L	−51.0	8.0	−11.0	10.425.444
	Lateral Geniculum Body		L	−21.0	−25.0	−2.0	9.180.390
	Cerebellum	*	R	33.0	−55.0	−14.0	9.042.595
	Thalamus	*	L	−6.0	−28.0	−5.0	8.535.957
	Middle Frontal Gyrus	9	L	−39.0	11.0	22.0	6.862.788
	Inferior Frontal Gyrus	47	L	−39.0	26.0	−2.0	6.730.738
	Parahippocampal Gyrus	35	L	−21.0	−28.0	−14.0	5.937.679
	Cerebellum	*	R	0.0	−49.0	−32.0	5.328.261
	Sub-Gyral	20	L	−36.0	−16.0	−17.0	4.988.610
	Parahippocampal Gyrus	35	R	21.0	−28.0	−14.0	4.333.858
	Parahippocampal Gyrus	34	L	−18.0	−10.0	−14.0	4.179.035
	Precentral Gyrus	4	L	−27.0	−22.0	64.0	3.165.962
53	Medial Frontal Gyrus	9	L	−6.0	53.0	34.0	3.812.754
	Medial Frontal Gyrus	9	L	−6.0	53.0	34.0	3.812.754
38	Caudate Body		L	−6.0	5.0	13.0	3.740.989
	Putamen		L	−18.0	−1.0	10.0	3.450.212
167	Medial Frontal Gyrus	6	L	−6.0	−1.0	55.0	6.942.378
38	Thalamus	*	L	−9.0	−13.0	7.0	5.033.025

Table 2.2. Brain activation for increasing negative story valence**.**

Cluster size	Region	BA		Talairach coordinates			Max. *t*-value
				X	*Y*	*Z*	
1556	Middle Temporal Gyrus	21	R	45.0	2.0	−23.0	−7.062.107
	Superior Temporal Gyrus	22	R	45.0	−22.0	−5.0	−6.687.765
	Superior Temporal Gyrus	22	R	57.0	−49.0	10.0	−5.981.107
	Inferior Frontal Gyrus	11	R	24.0	32.0	−20.0	−5.366.148
	Inferior Frontal Gyrus	47	R	48.0	29.0	−5.0	−5.282.379
	Parahippocampal Gyrus	36	R	39.0	−22.0	−20.0	−5.018.050
	Inferior Frontal Gyrus	45	R	48.0	23.0	10.0	−4.731.057
	Superior Temporal Gyrus	22	R	48.0	−55.0	16.0	−4.456.529
	Superior Temporal Gyrus	38	R	27.0	5.0	−38.0	−2.992.173
192	Cerebellum	*	R	21.0	−67.0	−29.0	−5.451.882
113	Caudate Body		R	9.0	2.0	13.0	−5.290.515
22	Cerebellar Tonsil	*	R	6.0	−46.0	−35.0	−4.393.444
23	Medial Frontal Gyrus	11	L	−3.0	47.0	−17.0	−5.042.429
713	Medial Frontal Gyrus	9	L	−6.0	44.0	31.0	−7.031.443
	Superior Frontal Gyrus	8	L	−6.0	26.0	49.0	−5.530.106
	Superior Frontal Gyrus	6	L	−9.0	14.0	55.0	−4.287.555
28	Cerebellum	*	L	−30.0	−88.0	−38.0	−5.304.901
3605	Middle Temporal Gyrus	21	L	−54.0	−1.0	−23.0	−7.581.751
	Inferior Frontal Gyrus	44	L	−45.0	11.0	19.0	−7.456.018
	Middle Temporal Gyrus	22	L	−54.0	−43.0	1.0	−7.107.245
	Superior Temporal Gyrus	38	L	−42.0	17.0	−23.0	−6.966.726
	Inferior Frontal Gyrus	11	L	−24.0	32.0	−20.0	−6.805.636
	Sub-Gyral	21	L	−48.0	−28.0	−2.0	−6.792.051
	Superior Temporal Gyrus	39	L	−42.0	−58.0	19.0	−6.568.569
	Inferior Frontal Gyrus	47	L	−45.0	29.0	−5.0	−6.332.211
	Caudate Body		L	−9.0	2.0	13.0	−5.455.053
	Medial Dorsal Nucleus		L	−9.0	−16.0	10.0	−5.293.430
	Amygdala		L	−18.0	−7.0	−8.0	−4.422.447
	Fusiform Gyrus	20	L	−39.0	−34.0	−17.0	−4.391.698
	Uncus	28	L	−27.0	2.0	−29.0	−4.382.841
	Fusiform Gyrus	37	L	−39.0	−43.0	−11.0	−4.220.282
	Middle Frontal Gyrus	6	L	−39.0	5.0	43.0	−4.129.689
	Brainstem, Red Nucleus		L	−6.0	−25.0	−5.0	−3.936.012
	Inferior Frontal Gyrus	47	L	−57.0	32.0	−17.0	−3.860.281
	Putamen		L	−27.0	−13.0	−8.0	−3.533.775
	Middle Frontal Gyrus	8	L	−33.0	20.0	40.0	−3.268.400

Table 2.3. Brain activation for increasing story liking**.**

Cluster size	Region	BA		Talairach coordinates			Max. *t*-value
				X	Y	Z	
103	Inferior Frontal Gyrus	45	R	54.0	20.0	10.0	4.666.930
518	Superior Temporal Gyrus	38	R	42.0	14.0	−20.0	5.721.092
	Superior Temporal Gyrus	38	R	54.0	20.0	−26.0	5.406.403
	Middle Temporal Gyrus	21	R	57.0	−1.0	−14.0	5.036.968
	Sub-Gyral	21	R	48.0	−10.0	−11.0	4.972.412
	Superior Temporal Gyrus	22	R	45.0	−25.0	−5.0	4.305.095
30	Precuneus	31	R	24.0	−73.0	22.0	4.332.990
25	Medial Frontal Gyrus	6	L	−6.0	2.0	61.0	4.623.124
52	Parahippocampal Gyrus	28	L	−21.0	−25.0	−8.0	3.635.541
	Cerebellum	*	L	−3.0	−31.0	−5.0	3.600.545
3341	Middle Temporal Gyrus	22	L	−54.0	−43.0	4.0	5.587.103
	Superior Temporal Gyrus	38	L	−48.0	11.0	−11.0	5.542.369
	Superior Temporal Gyrus	22	L	−48.0	−19.0	−5.0	5.364.425
	Precentral Gyrus	6	L	−45.0	−4.0	40.0	5.353.443
	Superior Temporal Gyrus	22	L	−54.0	−49.0	13.0	5.306.046
	Cerebellum	*	R	21.0	−73.0	−23.0	4.993.320
	Middle Occipital Gyrus	18	R	30.0	−79.0	−5.0	4.934.392
	Cuneus	19	L	−21.0	−88.0	28.0	4.894.963
	Inferior Frontal Gyrus	45	L	−57.0	14.0	19.0	4.853.875
	Lingual Gyrus	17	R	12.0	−88.0	−2.0	4.847.248
	Cuneus	18	L	−18.0	−94.0	13.0	4.788.170
	Middle Occipital Gyrus	18	R	24.0	−94.0	10.0	4.667.599
	Cerebellum	*	L	−33.0	−61.0	−8.0	4.616.873
	Middle Occipital Gyrus	19	L	−27.0	−88.0	10.0	4.599.266
	Inferior Occipital Gyrus	18	R	30.0	−94.0	−5.0	4.459.953
	Inferior Frontal Gyrus	45	L	−51.0	26.0	4.0	4.417.239
	Cuneus	30	R	6.0	−70.0	7.0	4.352.642
	Middle Occipital Gyrus	18	L	−36.0	−88.0	1.0	4.331.434
	Cerebellum	*	L	−15.0	−76.0	−11.0	4.291.461
	Fusiform Gyrus	19	L	−27.0	−82.0	−14.0	4.161.860
	Fusiform Gyrus	37	L	−39.0	−43.0	−11.0	4.049.331
	Lingual Gyrus	19	R	15.0	−55.0	−2.0	4.028.108
	Lingual Gyrus	18	L	−18.0	−55.0	4.0	3.980.167
	Cuneus	17	L	−9.0	−76.0	10.0	3.888.908
	Cerebellum	*	R	33.0	−58.0	−11.0	3.844.507
	Inferior Occipital Gyrus	18	L	−42.0	−88.0	−14.0	3.833.167
	Inferior Frontal Gyrus	11	L	−27.0	29.0	−23.0	3.559.359
	Cerebellum	*	L	−27.0	−37.0	−17.0	
	Parahippocampal Gyrus	30	R	15.0	−43.0	1.0	3.483.598

Table 2.4. Brain activation for increasing negative story valence combined with increasing story liking (valence × linking)**.**

Cluster size	Region	BA		Talairach coordinates			Max. *t*-value
				X	Y	Z	
266	Supramarginal Gyrus	40	L	−57.0	−46.0	31.0	−5.475.258
	Superior Occipital Gyrus	19	L	−36.0	−79.0	31.0	−4.544.866
132	Medial Frontal Gyrus	9/32	L	−9.0	41.0	16.0	−4.970.238
	Medial Frontal Gyrus	9	L	−9.0	41.0	28.0	−4.356.964
	Superior Frontal Gyrus	9	L	−18.0	44.0	28.0	−3.743.781
112	Middle Frontal Gyrus	8	L	−36.0	23.0	40.0	−4.474.544
34	Middle Frontal Gyrus	10	L	−42.0	56.0	7.0	−4.382.877
	Middle Frontal Gyrus	10	L	−33.0	47.0	−2.0	−3.886.662
38	Cerebellum	*	R	33.0	−70.0	−35.0	−3.703.044

Table 2.5. Brain regions showing positive connectivity with mPFC while reading negative stories > reading neutral stories**.**

Cluster size	Region	BA		Talairach coordinates			Max. *t*-value
				X	*Y*	*Z*	
84	Middle Temporal Gyrus	21	R	48.0	−1.0	−17.0	5.344.678
	Superior Temporal Gyrus	38	R	42.0	11.0	−20.0	5.268.341
941	Precentral Gyrus	6	R	42.0	−1.0	34.0	6.347.430
	Middle Frontal Gyrus	9	R	33.0	17.0	31.0	5.649.367
	Middle Frontal Gyrus	46	R	51.0	29.0	19.0	5.334.372
	Putamen		R	18.0	8.0	4.0	5.243.031
	Putamen		R	30.0	−1.0	7.0	5.216.119
	Inferior Frontal Gyrus	10/46	R	48.0	35.0	1.0	5.191.519
	Inferior Frontal Gyrus	10	R	39.0	47.0	1.0	5.183.762
	Inferior Frontal Gyrus	9	R	36.0	8.0	22.0	5.183.069
	Inferior Frontal Gyrus extending into Insula	45/47/13	R	48.0	20.0	4.0	5.168.429
	Caudate Head		R	18.0	17.0	1.0	4.853.752
	Thalamus	*	R	9.0	−1.0	4.0	4.456.534
192	Supramarginal Gyrus	40	R	42.0	−43.0	34.0	6.638.423
	Precentral Gyrus	4	R	45.0	−19.0	34.0	4.753.923
	Inferior Parietal Lobule	40	R	57.0	−34.0	34.0	4.307.735
37	Fusiform Gyrus	37	R	42.0	−52.0	−11.0	4.580.812
299	Putamen		R	33.0	−22.0	−2.0	5.305.676
	Hippocampus		R	27.0	−13.0	−14.0	5.082.986
	Superior Temporal Gyrus	22	R	48.0	−37.0	7.0	4.951.488
	Superior Temporal Gyrus	22	R	45.0	−22.0	−5.0	4.709.594
	Caudate Tail		R	36.0	−43.0	10.0	4.463.713
95	Superior Frontal Gyrus	10	R	12.0	56.0	−8.0	4.874.894
	Superior Frontal Gyrus	10	R	27.0	65.0	1.0	4.775.339
	Superior Frontal Gyrus	10	R	15.0	68.0	7.0	4.741.182
119	Cingulate Gyrus	32	R	6.0	14.0	37.0	5.477.295
70	Posterior Cingulate	29	L	0.0	−43.0	10.0	5.409.723
	Posterior Cingulate	23	R	3.0	−37.0	22.0	4.375.017
49	Cerebellum	*	L	−3.0	−58.0	1.0	4.554.553
104	Thalamus (ventral lateral nucleus)		L	−18.0	−16.0	10.0	4.994.545
	Thalamus (anterior nucleus)		L	−6.0	−7.0	10.0	4.737.922
33	Middle Frontal Gyrus	9	L	−24.0	29.0	34.0	4.578.666
728	Amygdala		L	−33.0	−7.0	−14.0	6.569.848
	Superior Temporal Gyrus	38	L	−45.0	20.0	−23.0	6.025.189
	Middle Temporal Gyrus	21	L	−48.0	−4.0	−14.0	5.425.207
	Superior Temporal Gyrus	22	L	−48.0	−22.0	−8.0	5.288.910
	Inferior Frontal Gyrus extending into Insula	47/13	L	−30.0	14.0	−17.0	5.172.719
	Putamen		L	−21.0	11.0	4.0	4.972.111
	Inferior Frontal Gyrus	9	L	−45.0	5.0	34.0	4.660.889
	Middle Frontal Gyrus	46	L	−42.0	17.0	19.0	4.500.771
	Inferior Frontal Gyrus extending into Insula	9/13	L	−33.0	8.0	22.0	4.102.611
	Precentral Gyrus	6	L	−57.0	−4.0	37.0	3.943.306
1027	Inferior Parietal Lobule	40	L	−48.0	−25.0	25.0	6.028.291
	Inferior Parietal Lobule	40	L	−39.0	−49.0	37.0	5.800.646
	Inferior Parietal Lobule	40	L	−51.0	−34.0	34.0	5.711.774
	Postcentral Gyrus	2	L	−36.0	−25.0	37.0	5.598.609
	Precuneus	7	R	24.0	−67.0	28.0	4.901.719
	Precuneus	7	R	6.0	−52.0	34.0	4.705.517
	Superior Temporal Gyrus	13	L	−51.0	−43.0	19.0	4.411.334
	Precuneus	31	L	−18.0	−73.0	28.0	4.256.221
	Insula	13	L	−30.0	−22.0	25.0	4.077.991
	Precuneus	7	L	−18.0	−64.0	40.0	3.988.875

Table 2.6. Brain regions showing positive connectivity with mPFC depending on individual tendency to put feel concern for other people (Positive correlation between the empathic concern scale and mPFC–connectivity while reading negative stories > reading neutral stories)**.**

Cluster size	Region	BA		Talairach coordinates			Max. *t*-value
				X	*Y*	*Z*	
81	Inferior Frontal Gyrus/Anterior Insula	47/13	R	33	29	1	0.785256
	Putamen		R	24	8	−5	0.655270
17	Posterior Cingulate	31	R	18	−58	19	0.719141
16	Middle Frontal Gyrus	8	L	−33	17	43	0.830213
53	Insula	13	L	−36	14	−2	0.733469

Table 2.7. Prestudy results for valence and liking**.**

Conditions	Valence (Scale −3 to +3)		Liking (Scale 1–7)	
	Mean	SD	Mean	SD
Negative stories	−1.36	0.60	3.67	0.63
Neutral stories	0.52	0.38	3.60	0.51

Mean values for each story were used in the fMRI experiment to modulate parametric regressors for the effect of valence and liking during reading. A 2 × 2 repeated measures ANOVA was conducted with the factors story type (negative, neutral) and context (real, invented) to examine whether participant's judgments of valence reflect a clear differentiation between stories that have been categorized as neutral or negative in earlier studies during the stimulus selection phase. The main effect for story type [$F_{(1, 31)} = 72.83$, $p < 0.001$] showed that this is the case. Results revealed no main effect of context [$F_{(1, 31)} < 1$, $p < 0.717$] and no context × story type interaction [$F_{(1, 31)} = 3.67$, $p < 0.065$]. We did not find any effect for liking judgments. Stories were equally liked, independently of valence [$F_{(1, 31)} < 1$, $p < 0.741$] or context labelling [$F_{(1, 31)} = 1.33$, $p < 0.258$].

Descriptive data on the item level show a clear difference on average valence for negative stories ($M = -1.36$, $SD = 0.60$) and neutral stories ($M = 0.52$, $SD = 0.38$). Average liking values are very similar for negative ($M = 3.67$, $SD = 0.63$) and neutral ($M = 3.60$, $SD = 0.51$) texts. The latter finding fits nicely to the observation that an object must not provide positive valence in order to be liked.

Chapter 3.

Fact vs fiction - how paratextual information shapes our reading processes

This chapter was published as

Altmann, U., Bohrn, I. C., Lubrich, O., Menninghaus, W., & Jacobs, A. M. (2014). Fact *vs* fiction—how paratextual information shapes our reading processes. *Social Cognitive and Affective Neuroscience*, *9*(1), 22–29. http://doi.org/10.1093/scan/nss098 doi:10.1093/scan/nss098 SCAN (2014) 9, 22–29

Fact *vs* fiction—how paratextual information shapes our reading processes

Ulrike Altmann,[1,2] Isabel C. Bohrn,[1,2] Oliver Lubrich,[2,3] Winfried Menninghaus,[2,4] and Arthur M. Jacobs[1,2,5]
[1]Department of Education and Psychology, [2]Languages of Emotion, Freie Universität Berlin, D-14195 Berlin, Germany, [3]German and Comparative Literature, Universität Bern, Switzerland, [4]Department of Philosophy and Humanities and [5]Dahlem Institute for Neuroimaging of Emotion (D.I.N.E.), Freie Universität Berlin, D-14195 Berlin, Germany

Our life is full of stories: some of them depict real-life events and were reported, e.g. in the daily news or in autobiographies, whereas other stories, as often presented to us in movies and novels, are fictional. However, we have only little insights in the neurocognitive processes underlying the reading of factual as compared to fictional contents. We investigated the neurocognitive effects of reading short narratives, labeled to be either factual or fictional. Reading in a factual mode engaged an activation pattern suggesting an action-based reconstruction of the events depicted in a story. This process seems to be past-oriented and leads to shorter reaction times at the behavioral level. In contrast, the brain activation patterns corresponding to reading fiction seem to reflect a constructive simulation of what might have happened. This is in line with studies on imagination of possible past or future events.

Keywords: emotion; emotion regulation; fact; fiction; fMRI; literature; narrative; reading; theory of mind

INTRODUCTION

When we watch a movie, does it make any difference whether it claims to be ‘based on a true story’ or advises us that ‘the following story is fictional and does not depict any actual person or event’? Does it make a difference whether we read a book labeled ‘autobiography’ or ‘novel’? Many people would say it does.

Starting at an age of 3 years, children are able to tell apart what an object looks like from what it really is (Woolley and Wellman, 1990) and to distinguish between factual and fictional worlds (Woolley and Cox, 2007). It is also known that readers can learn from fiction and integrate information from fictional worlds into their real-world knowledge (Gerrig and Rapp, 2004). Reading fiction has the capacity to modify personality traits (Djikic *et al.*, 2009) and is associated with better performance on scales of empathy and social abilities (Mar *et al.*, 2006). But what causes this difference? In the present study, we investigated the neural mechanisms underlying the processing of factual and fictional contents in reading.

Although, theoretically, all kinds of stories, be they factual or fictional, are objects of narratology, this subdiscipline of literary studies focuses on narrative fiction (Genette, 1990; Smith, 2009). Note that fiction and literature designate independent textual properties. The first refers to a descriptive concept, whereas the second depends on aesthetic evaluation; therefore, a fictional text can but must not also be a literary one and vice versa (Lamarque and Olsen, 1994).

A reader can obtain information about the status of a certain text type (factual or fictional) in at least two ways. The first source of information arises from text-internal genre signals or ‘symptoms’ of fictionality (Hamburger, 1973; see Genette, 1990 for discussion). But those signals are neither necessary nor sufficient: authors often play with the reader’s knowledge and expectations, leading literary scholars to conclude that ‘there is no textual property, syntactical or semantic that will identify a text as a work of fiction’ (Searle, 1975; see also Zwaan, 1994).

The second source of information, so-called paratext (Genette, 1990), is mostly provided even before the reader opens a book, through cover details, like the name of the author, the title or genre indications (e.g. ‘Novel’ or ‘Autobiography’). Such signals provide key knowledge to the reader and trigger certain expectations. If a story is signaled to be factual (e.g. newspaper, autobiography, historiography), readers expect truthfulness with respect to the real world (Gerrig and Rapp, 2004). On the other hand, the cognitive and emotional involvement in a fictional story (e.g. transportation or immersion) depends on previous knowledge and perceived realism (Green, 2004; see Jacobs, 2011, for different factors underlying immersion in reading). In addition, when a story is labeled as a work of fiction, the reader signs a kind of ‘fictional agreement’ (Eco, 1994, p. 75), accepting that the author pretends (or makes believe) the content of his story *as if* it was real. Genette (1990) stated that ‘a fictional narrative is [. . .] a pretence or simulation of a factual narrative’ (p. 757). Similarly, Oatley and Olson (2010) argued that factual and fictional works follow different tasks: cooperation and alignment for real-world interaction on the one hand, imagination and simulation for fictional interaction on the other (see also Mar and Oatley, 2008).

If this were true, we would expect that the mere labeling of a text as fictional invites the reader to enter the game of pretence and simulation (German *et al.*, 2004; Whitehead *et al.*, 2009). That should be associated with similar neuronal patterns as have been observed in studies on mental imagery (Decety and Grèzes, 2006; Dinstein *et al.*, 2007) or simulation of self *vs* others (Decety and Grèzes, 2006). Across these studies, a regularly reported finding is the engagement of the inferior parietal lobule (IPL), which has been found to be involved during the construction of a vivid scene (Summerfield *et al.*, 2010) and, jointly with the posterior cingulate cortex (PCC) and the dorsolateral prefrontal cortex (DLPFC), during mental simulations in order to solve future problems (Gerlach *et al.*, 2011). Whereas readers are primarily interested in information gathering during factual reading they expect enjoyment when reading fictional texts (Galak and Nelson, 2010; Jacobs, 2011). We assume that enjoyment during reading fiction is not exclusively driven by stylistic features, but additionally comes from the extent to which a text invites the reader for relational thinking (Raposo *et al.*, 2010) and simulation processes as mentioned earlier.

Received 20 December 2011; Accepted 15 August 2012
Advance Access publication 5 September 2012

This research was supported by the DFG-funded Cluster of Excellence ‘Languages of Emotion’ and the Dahlem Institute for Neuroimaging of Emotion (D.I.N.E.), Freie Universität Berlin. We are grateful to Christine Knoop for helpful comments on earlier versions of the manuscript. We also thank Isabel Amberger, Moritz Matejka, Anja Wenzel, and Skadi Wilke for their help in subject recruitment and data acquisition.

Correspondence should be addressed to Ulrike Altmann, Department of Education and Psychology, Freie Universität Berlin, Habelschwerdter Allee 45, D-14195 Berlin, Germany. E-mail: u.altmann@fu-berlin.de

Growing evidence suggests the frontopolar cortex (FPC) to play a role in such processes. The FPC has been found activated in tasks which require constructive mental processes like mind-wandering (Gilbert *et al.*, 2005; Dumontheil *et al.*, 2010), simulation of the future (Schacter *et al.*, 2008) and complex imagery of hypothetical events (Addis *et al.*, 2009). In addition to the IPL, we therefore expect the lateral prefrontal cortex (including FPC and DLPFC) to be engaged in reading fiction. According to Mar and Oatley, (2008), especially fictional texts have the capacity to provide the reader with simulations of social information and experiences that might prepare the reader for similar real-life interactions in the future. The authors proposed the involvement of theory of mind (ToM) processes as one function of the simulation during reading fictional texts and the finding that reading fiction goes along with better performance on scales of empathy and social abilities (Mar *et al.*, 2006) speaks in favor to that assumption. If the neural processes underlying reading fiction recruit the lateral PFC because they resemble those involved in mind-wandering and the imagination of hypothetical events, it seems reasonable to assume that the strength of lateral PFC activation predicts the involvement of brain areas that support mentalizing and perspective taking, especially the medial prefrontal cortex (mPFC) (Decety and Jackson, 2004; Frith and Frith, 2006). This can be examined with psychophysiological interaction (PPI) analysis (see 'Methods' section for further details) which allows to test whether a brain region (i.e. lateral PFC) shows a stronger coactivation with other brain regions during one task (reading fiction) as compared to another (reading facts). The mPFC also constitutes one key region in the text comprehension network (Ferstl and von Cramon, 2002; Ferstl *et al.*, 2008) and a meta-analysis by Mar (2011) revealed a functional overlap in the right mPFC between ToM stories and narrative comprehension stories.

Story comprehension presupposes an understanding of the propositions derived from the meanings of words and sentences (text level) and the integration of this verbatim information with the reader's world knowledge and his knowledge about the discourse context which leads to the construction of a model of what the text is about (situation model; van Dijk and Kintsch, 1983). In our study, the reading of stories in general, independently of the given context (fact or fiction), should replicate results on the story comprehension network reflecting these integration processes, including the mPFC, the inferior frontal gyrus (IFG), the anterior temporal lobes (aTL) and the posterior superior temporal gyrus (Ferstl and von Cramon, 2002; Xu *et al.*, 2005; Ferstl *et al.*, 2008; Yarkoni *et al.*, 2008; Mar, 2011).

To our knowledge, there exist no studies so far which directly investigated the fact/fiction distinction. But previous studies examined the neuronal processing of real life as compared to animated film scenes (Han *et al.*, 2005; Mar *et al.*, 2007, and Abraham *et al.,* 2008b) let their participants indicate whether it was possible to interact with real (e.g. George Bush) or fictional characters (e.g. Cinderella). They found selective activation of the mPFC and the PCC/retrosplenial cortex (RSC) when participants evaluated real persons and concluded that real persons elicit more autobiographical memory retrieval as they have a higher personal relevance (see also Summerfield *et al.*, 2009).

However, as all those studies used slightly different materials across conditions, it cannot be excluded that the results were influenced by semantic or visual properties of the stimuli. In addition, the aforementioned studies used either phrases or film clips but not any more complex linguistic material. The aim of the current study was to investigate the neural mechanisms underlying the processing of factual and fictional contents during the reading of simple stories. In order to exclude linguistic differences between conditions, we only changed the context label declaring the text as either factual or fictional. In particular, this paradigm allowed us to investigate how a certain 'reception agreement' which is offered to the reader determines the neural processing of a given text. As empirical research often uses stimuli with narrative and/or fictional content, e.g. paradigms investigating theory of mind, empathy, or emotion regulation, it might be helpful for empirical psychologists as well as for scholars of literature to learn more about possible differences in the neural processing of factual and fictional contents.

METHODS

Stimuli

We used 80 short narratives (mean number of words: 48, range: 41–57). We adopted half of them from the so-called *black stories* (moses Verlag GmbH, Kempen, www.moses-verlag.de), a game based on short narratives with negatively valenced plots (crimes, disasters, accidents), as to be found in daily news stories, and also in novels or crime stories. Another 40 narratives with comparable settings but neutral emotional valence were created in order to prevent readers from an oversaturation of negatively valenced texts. Prestudies made sure that the style of all micro-narratives is sufficiently neutral or ambiguous to equally correspond to that of a typical newspaper article or to that of a literary story.

Participants

Twenty-four healthy, right-handed volunteers (12 female, mean age: 26.5; age range: 18–45) took part in the study. Participants were German native speakers and skilled readers. Only participants who did not know the *black stories* game and were naive to its content were included. All participants had normal or corrected to normal vision and gave informed written consent in accordance with the local research ethics committee.

Task

A 2×2 repeated measures design was applied with one factor varying the context ('real', 'invented') and the second factor reflecting the story type ('negative', 'neutral'). A total of 80 stories were presented, 20 in each factor combination. We pseudo-randomized the order of conditions as well as the presentation of the narratives across conditions. All participants read exactly the same narratives, only the label prior to each narrative ('real', 'invented') was pseudo-randomized across subjects. During the fMRI experiment, a narrative was presented for 20 s, displayed on five lines (shown 4 s each). We set up the presentation time by using RT data from a pilot study and used the mean reading time in seconds plus one standard deviation ($M = 12{,}63$; s.d. $= 6.45$; in seconds). In pilot tests with volunteers in the scanner, this timing has proved to be comfortable for most reader. Prior to the story, a context label (either 'real' or 'invented') was presented for 3 s in order to signal either a factual or a fictional source. Participants were requested to read the text silently and solve a verification task following each text. By means of a cue ('real?' or 'invented?'—*German: 'Real?'/'Erfunden?'*), participants were asked, as an attention control task, whether the story they just read was real or invented. Participants answered via button press ('yes', 'no'). The verification cues were presented in a pseudo-randomized order so as to avoid motor preparation during the reading phase and to assure an equal assignment of question cues and required responses with regard to each condition. Additionally, participants completed the interpersonal reactivity index (IRI Davis, 1983; German version: Paulus, 2009) which provides a four-dimensional self-report estimate of empathy. In this study, we focus on the 'fantasy' subscale which assesses the individual tendency to put oneself into fictional characters and thus might influence the neural processing during reading fiction (please refer to 'Data Analysis' section for further details).

fMRI data acquisition

Functional data were acquired on a Siemens Tim Trio 3T MR imager. Four runs of 425 volumes were measured using a T_2^*-weighted echo-planar sequence [slice thickness: 3 mm, no gap, 37 slices, repetition time (TR): 2 s, echo time (TE): 30 ms, flip angle: 90°, matrix: 64 × 64, field of view (FOV): 192 mm, voxel size: 3.0 mm × 3.0 mm × 3.0 mm] and individual high-resolution T_1-weighted anatomical data (MPRAGE sequence) were acquired (TR: 1.9, TE: 2.52, FOV: 256, matrix: 256 × 256, sagittal plane, slice thickness: 1 mm, 176 slices, resolution: 1.0 mm × 1.0 mm × 1.0 mm).

Data analysis

Behavioral measures were analyzed with SPSS (SPSS Inc., Chicago, IL, USA). Analysis of fMRI data was conducted with Brain Voyager QX [2.0] (Brain Innovation, Maastricht, The Netherlands; Goebel *et al.*, 2006). Functional data were corrected for head motion and for different slice scan times using cubic spline interpolation. To remove low-frequency signal drifts, a high-pass filter was applied with a cutoff period three times the block length. Spatial smoothing was performed using a Gaussian filter of 8 mm, full width at half maximum. The functional maps of each participant were then transformed into standard Talairach space (Talairach and Tournoux, 1988). Whole-brain statistical analysis was performed according to the general linear model as implemented in Brain Voyager QX. On the first level, the model was generated with two blocked regressors for the reading of stories (invented: reading fiction, real: reading fact) and two additional blocked regressors, one for the context labeling period prior to each story and one for the attention-task period following each story. In this article, we will focus on the main effect of context (invented *vs* real). Individual contrast images from the first-level analysis were applied to a second-level random effects group analysis, in which we tested for the main effect of context (invented *vs* real). All contrasts were corrected for multiple comparisons ($P < 0.05$) at the cluster level using Monte Carlo simulations in order to calculate minimum cluster size thresholds (initial threshold at the voxel level $P < 0.001$ uncorrected). As this is, to our knowledge, the first study investigating the neurobiological mechanism for the processing of fictional as compared to factual contents and in order to provide a comprehensive picture of the results, we conducted the corrections for multiple comparisons ($P < 0.05$) not only with an initial threshold at the voxel level $P < 0.001$ uncorrected, but also at $P < 0.003$ uncorrected and $P < 0.005$ uncorrected, respectively.

In correspondence with our initial hypotheses, we identified the right frontopolar cortex (rFPC) to be involved in reading fiction and selected it as seed region for further PPI analysis (Friston *et al.*, 1997) with a sphere of 8 mm around the peak voxel (45, 47, 10). PPI analysis allows identifying brain regions that show stronger coactivation during one task (reading fiction) as compared to another (reading fact). Particularly, we were interested in whether context-specific rFPC activation (i.e. reading in a fictional mode) is 'coupled' with ToM-related brain areas, especially the mPFC. The PPI regressor was calculated as the element-by-element product of the mean-corrected activity in the rFPC region of interest and the task vector coding for the context-specific effect of reading fiction compared to reading fact. To identify areas of the brain that showed increased activation during reading fiction when rFPC activation increased, individual PPI regressors where entered into a second-level random effects analysis. Finally, we repeated the PPI analysis with individual scores on the IRI fantasy scale as a covariate to examine areas of the brain that showed a stronger coupling with rFPC depending on individual tendency to put oneself into fictional characters. A stronger 'readiness' of individuals to 'transpose themselves imaginatively into the feelings and actions of fictitious characters in books, movies and plays' (Davis, 1983, p. 114) might lead to a stronger coupling between FPC and the mPFC.

RESULTS

Behavioral results

Table 1 shows the descriptive data for the behavioral measures during the verification task. RTs ranged from 1067 to 1235 ms across conditions. A 2 × 2 repeated measures ANOVA was conducted to examine the effects of context (real, invented) and story type (negative, neutral) on RTs during the verification task. The results indicate that participants responded faster when a story had been presented in the real context condition (main effect of context; $F_{1,23} = 5.8$, $P < 0.024$). Results revealed no main effect of story type ($F_{1,23} = 2.8$, $P < 0.106$) and no context × story type interaction ($F_{1,23} < 1$, $P < 0.660$).

A 2 × 2 repeated measures analysis on the percentage of correct responses revealed no main effect of context ($F_{1,23} < 1$, $P < 0.498$) or story type ($F_{1,23} < 1$, $P < 0.404$) and no interaction ($F_{1,23} < 1$, $P < 0.750$). The mean percentage of correct responses across conditions was 94.5 ± 6.8.

fMRI results

First, we calculated the neural activation of story reading by calculating the conjunction of factual reading and fictional reading. As expected, reading stories, independently of the given context (fact or fiction), revealed an activation pattern that is regularly reported in studies on story comprehension (Ferstl and von Cramon, 2002; Xu *et al.*, 2005; Ferstl *et al.*, 2008; Yarkoni *et al.*, 2008; Mar, 2011). Both reading modes shared extensive bilateral activation in the IFG (BA 9, 45, 47), the mPFC (BA 8, 9), temporal poles (TPs: BA 38), amygdala, thalamus and early visual processing areas (BA 17, 18, 19) that extended to the fusiform gyrus. The activation covered also the middle temporal gyrus (MTG) and superior temporal gyrus (STG) extending to the posterior superior temporal sulcus (BA 21, 22, 39) on the left (for further details, please refer to Supplementary Table S1).

Second, we compared factual reading with fictional reading (real > invented) (Table 2 and Figure 1). Reading a text on the assumption that it depicted real events selectively engaged regions in the RSC (BA 30), right TP (BA 38), left lateral premotor cortex (BA 6) and bilateral lateral cerebellum. This activation pattern extended to the ventral striatum and left posterior middle temporal gyrus (MTG: BA 39/19) [cluster level corrected ($P < 0.05$), initial voxel level threshold $P < 0.003$ uncorrected] and to the left STG/MTG (BA 22, 21) [cluster level corrected ($P < 0.05$), initial voxel level threshold $P < 0.005$ uncorrected].

Third, the reverse contrast (invented > real) was used to examine brain areas which were more respondent during reading on the assumption that the texts were invented (Table 2 and Figure 1). This contrast revealed activations in the rFPC/DLPFC (BA 10/9), bilateral mid-cingulate/posterior cingulate cortex (MCC/PCC: BA 24, 31), right dorsal posterior cingulate cortex (dPCC: BA 31) and right IPL/supramarginal gyrus (BA 40). Additional regions were observed in the right FPC/DLPFC (BA 10/46), left dorsal anterior cingulate cortex (dACC: BA 24, 32), left precuneus (BA 7) [cluster level corrected ($P < 0.05$), initial voxel level threshold $P < 0.003$ uncorrected] and right DLPFC (BA 8) [cluster level corrected ($P < 0.05$), initial voxel level threshold $P < 0.005$ uncorrected].

PPI analysis (Table 3) showed that rFPC covaried context dependent (invented > real) with the right ACC/medial frontal gyrus [ACC/MFG: BA 10 ($r = 0.566$, $P = 0.0001$)]. Additional functional interactions could be found in the right MFG (BA 9), right aTL (BA 38), left PCC (BA 31), right IFG (BA 9) and bilateral fusiform gyrus (BA 37) [cluster level corrected ($P < 0.05$), initial voxel level threshold $P < 0.005$ uncorrected]. Additionally, we examined which areas of the brain

Table 1 Descriptive data (mean and standard deviation) of the behavioral measures (reaction time and percentage of correct responses) for all conditions

Conditions	Reaction time (ms)		Percentage correct	
	Mean	s.d.	Mean	s.d.
Real_Negative	1101.99	229.35	94.58	6.74
Real_Neutral	1141.20	239.65	93.54	7.73
Invented_Negative	1167.52	218.34	95.21	5.61
Invented_Neutral	1193.53	169.87	94.79	7.14

Table 2 Brain activation during fact-reading and fiction-reading

Region	Laterality	Broadmann area	Talairach coordinates			t
			x	y	z	
Fact > fiction						
Temporal pole	R	38	42	23	−20	4.10
Cerebellum	R	–	21	−73	−29	4.81
Caudate head*	R	–	3	5	1	3.86
Retrosplenial cortex	L	30	−6	−40	4	4.49
Cerebellum	L	–	−24	−82	−35	4.05
			−14	−76	−32	3.89
Premotor cortex	L	6	−45	2	49	4.87
Posterior middle temporal gyrus*	L	19/39	−45	−64	19	3.88
Middle temporal gyrus/superior temporal gyrus**	L	21/22	−54	−28	−2	3.35
Fiction > fact						
Inferior parietal lobule/supramarginal gyrus	R	40	48	−40	43	−4.32
			42	−40	34	−4.17
Frontopolar cortex/dorsolateral prefrontal cortex	R	10/9	36	44	25	−5.53
Frontopolar cortex/dorsolateral prefrontal cortex*	R	10/46	45	47	10	−3.80
Dorsolateral prefrontal cortex**	R	8/9	33	20	37	−3.38
Mid-cingulate cortex/posterior cingulated cortex	R	24/31	15	−19	37	−5.45
Dorsal posterior cingulate cortex	R	31	15	−43	40	−4.14
Dorsal anterior cingulate cortex**	R	24/32	9	8	37	−3.43
Mid-cingulate cortex/posterior cingulated cortex	L	24/31	−12	−22	43	−4.20
			−15	−16	37	−4.15
Dorsal anterior cingulate cortex*	L	24/32	−9	5	37	−3.55
			−6	17	34	−3.41
Precuneus/superior parietal lobule*	L	7	−21	−52	40	−3.84

Brodman area, Talairach coordinates and t-score for the peak voxel of significantly activated regions; corrected for multiple comparisons at cluster level ($P < 0.05$) with an initial voxel level threshold of $P < 0.001$ (uncorrected). At an initial voxel level threshold of $P < 0.003$* and $P < 0.005$** (uncorrected) additional regions became engaged.

showed higher functional connectivity with rFPC during reading in a fictional mode, depending on self-report scores at the fantasy scale. Individuals who reported a stronger tendency to put themselves into characters of novels and films showed a stronger coupling between rFPC and the right MFG (BA: 10, 8 49 0) (Figure 2), right precuneus/superior parietal lobule (BA 7, 18 − 61 58) and also [cluster level corrected ($P < 0.05$), initial voxel level threshold $P < 0.005$ uncorrected] in the right IPL (BA 40, 36 − 37 61).

DISCUSSION

Reading facts

Reading stories on the assumption that they refer to real events, as reported in a newspaper or a magazine, selectively yielded an activation pattern comprising the RSC, right TP, left MTG/STG, the ventral striatum, the premotor cortex and the cerebellum.

The premotor cortex and the cerebellum which were more strongly activated in the facts condition than in the fiction condition are likely to be part of the mirror neuron system and involved in action observation (Buccino *et al.*, 2001; Calvo-Merino *et al.*, 2006), imitation (Jackson and Decety, 2004) or imagination (Decety and Grèzes, 2006). Reading in a fictional mode also engaged the left lateral temporal regions (MTG/STG) and right TP. Whereas readers expect entertainment from fictional stories they gather for information when reading factual texts (Galak and Nelson, 2010) to update their world knowledge (Zwaan, 1994). In line with that, a study by Hasson *et al.* (2007) revealed that left lateral temporal activation (extending from posterior dorsal STG/MTG to TP) predicted accurate subsequent memory for story content and showed to be more responsive to informative than to less informative story endings. Left lateral STG was also found to be active during attention to action- and space-related story features (Cooper *et al.*, 2011) and appears to become particularly engaged during the imitation of another person (Decety *et al.*, 2002). Moreover, the anterior temporal region has been found to be more engaged when participants observed a real hand rather than a virtual hand performing grasping movements (Perani *et al.*, 2001). Thus, the prior knowledge that a text is a factual one seems to guide the readers comprehension strategies toward an understanding of what happened in a story. The reader's imagination during text processing might be triggered on the actions and their outcomes, as factual stories appear to describe unchangeable, past completed events compared to a more hypothetical consideration of events during fictional reading (see 'Discussion' section below).

In a behavioral study with comparable material, it has been shown that reading in a factual mode resulted in a stronger situation model than reading in a fictional mode (Zwaan, 1994). The construction of such a model requires the reader's understanding of the single events described in a text and their interrelations. This textual information then needs to be integrated into the reader's world knowledge, being represented in autobiographical memory (van Dijk and Kintsch, 1983). In addition to the lateral temporal activations, the RT results of the present fMRI experiment speak in favor of a stronger situation model in the factual reading mode as the participants responded faster in the verification task when a text was presented as 'real' (accordingly, texts read in a factual mode were rated as more familiar in a prestudy). Similarly, Abraham *et al.* (2008a) found shorter RTs for statements that were personal or referred to the past than to impersonal- or future-related statements, as well as for the evaluation of real compared to fictional characters (Abraham *et al.*, 2008b). The texts used in the current experiment comprised events as regularly reported in the daily news, in TV documentaries and newspaper reports. This holds especially for the narratives, depicting accidents and criminal offences, including homicide. As the textual information presented to the participants was identical across conditions, we assume that reading in a factual mode signals a higher personal relevance to the reader and therefore elicits more autobiographical memory retrieval. This interpretation is in line with the activation of the RSC and the striatum we observed for the factual reading condition. Especially the left RSC was found to be responsive to the realness and self-relevance of recalled events (Summerfield *et al.*, 2009) or when answering questions concerning real persons as compared to fictional characters (Abraham *et al.*, 2008b). The ventral striatum is known to be involved in the processing of reward and positive affect (Elliot *et al.*, 2000; Roy *et al.*, 2012), learning (Willems *et al.*, 2010) and social cognition (Singer *et al.*, 2006; Tricomi *et al.*, 2010). The activation we observed in the ventral striatum likely reflects the salience emanating from the action-relevance of the texts when they were read in the fact condition, which fits to the finding that activation in this region has been reported

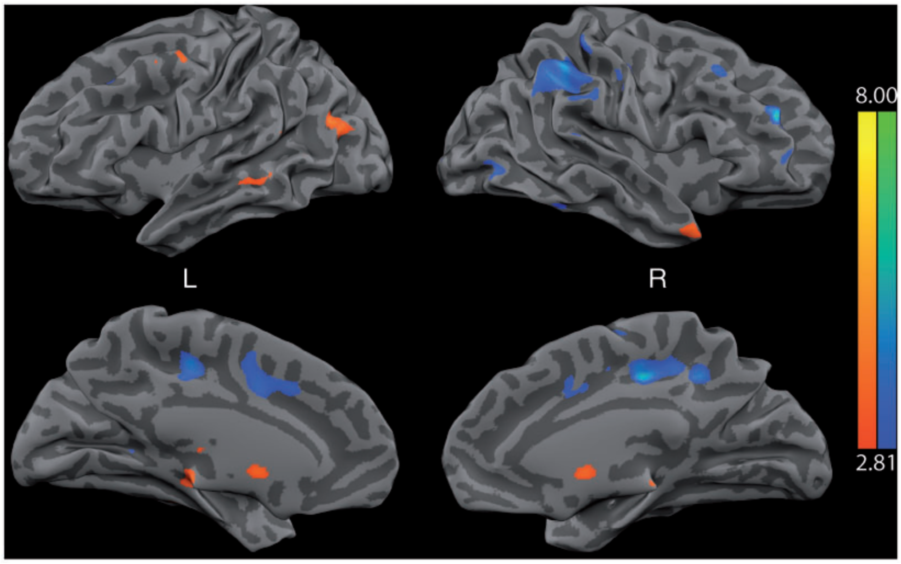


Fig. 1 Brain areas activated when comparing reading facts with reading fiction. Areas of selective activation for the contrast (**A**) real *vs* invented (warm colors) and (**B**) invented *vs* real (cold colors); visualization: cluster level corrected ($P < 0.05$), initial voxel level threshold $P < 0.005$ uncorrected.

Table 3 Task-related PPI analysis of rFPC seed

Region	Laterality	Broadmann area	Talairach coordinates			*t*
			x	*y*	*z*	
Anterior cingulate gyrus/medial frontal gyrus	R	10	3	50	10	4.36
Fusiform gyrus**	R	37	42	−43	−23	5.36
Cerebellum**	R	–	21	−88	−29	4.71
Medial frontal gyrus/anterior cingulate gyrus**	R	9/32	12	38	22	4.40
Medial frontal gyrus/superior temporal gyrus**	R	25/47	12	11	−20	4.34
Thalamus**	L	–	−3	−34	1	4.51
Posterior cingulate**	L	31	−6	−55	25	3.84
Fusiform gyrus**	L	37	−42	−58	−23	4.84

The anterior cingulate gyrus showed a significant coactivation with rFPC during reading fiction (invented > real); corrected for multiple comparisons at cluster level ($P < 0.05$) with an initial voxel level threshold of $P < 0.001$ (uncorrected). At an initial voxel level threshold of $P < 0.005$** (uncorrected), additional regions became engaged.

in response to action-relevant, salient stimuli, even though no reward was connected with these stimuli (Zink *et al.*, 2003).

Our results thus suggest an action-based (and possibly past-oriented) reconstruction of what happened when the events depicted in a text are supposed to be real.

Reading fiction

Reading stories on the assumption that they refer to fictional events such as those narrated in a novel, a short story or a crime story selectively engaged an activation pattern comprising the dACC, the right lateral FPC/DLPFC and left precuneus, which are part of the fronto-parietal control network (Smallwood *et al.*, 2012) as well as the right IPL and dPCC, which are related to the default mode network (Raichle *et al.*, 2001).

The activation we found in the dACC was mainly located in Brodmann areas 24′ and 32′ (Nieuwenhuys *et al.*, 2007). This region is involved in working memory, attention, action monitoring and pain perception. However, it also reacts sensitively to emotional valence and seems to play a role during the evaluation and representation of the value of future action (see Amodio and Frith, 2006 for a review). Together with the DLPFC, the dACC plays an important role in emotion regulation, especially during downregulation of negative emotions. Strikingly, in studies on emotional downregulation, participants were often instructed to imagine, for instance, that the stimuli were not real (Eippert *et al.*, 2007; Hermann *et al.*, 2009), but rather a film scene (McRae *et al.*, 2008).

A prominent role in the fiction contrast can be ascribed to the right lateral FPC as one part of the fronto-parietal control network. Dumontheil *et al.* (2010) found a U-shaped relation between task difficulty and frontopolar activation. According to the authors, the lateral FPC is responsive to very simple tasks, which allow for mind-wandering, as well as for difficult tasks, which require the handling of self-produced information. In a meta-study, Gilbert *et al.* (2005) demonstrated that specific lateral frontopolar activation is associated with longer behavioral RTs and suggested this lateral activation to be related to attention shifts for information generation or stimulus-independent thought. In fact, the lateral frontopolar region has been associated with the simulation of past and future events when compared to the recall of reality-based episodic memories (Addis *et al.*, 2009; see also Schacter *et al.*, 2008). This suggests a process of constructive content simulation taking place during fictional reading. The PPI analysis showed positive functional connectivity between rFPC and brain regions related to ToM and empathy (mPFC, PCC, precuneus, aTL). In accordance with our initial hypotheses, these data support the assumption that reading fiction invites for mind-wandering and thinking about what *might* have happened or could happen. Such simulation processes require perspective taking and relational inferences (Raposo *et al.*, 2010) which make a coactivation of ToM and empathy related areas likely.

Reading texts as fictional thus appears to exceed mere information gathering. Our results suggest that readers perceive the events in a fictional story as possibilities of how something might have been, which leads to an active simulation of events—similar to the simulation of a possible past or a possible future (Schacter *et al.*, 2008; Addis *et al.*, 2009). Along the way, the reader's construction of a situation model then might remain flexible. Zwaan (1994) stated that reading in a fictional (compared to factual) mode implies a focus on the text basis and attention to less important information. During literary

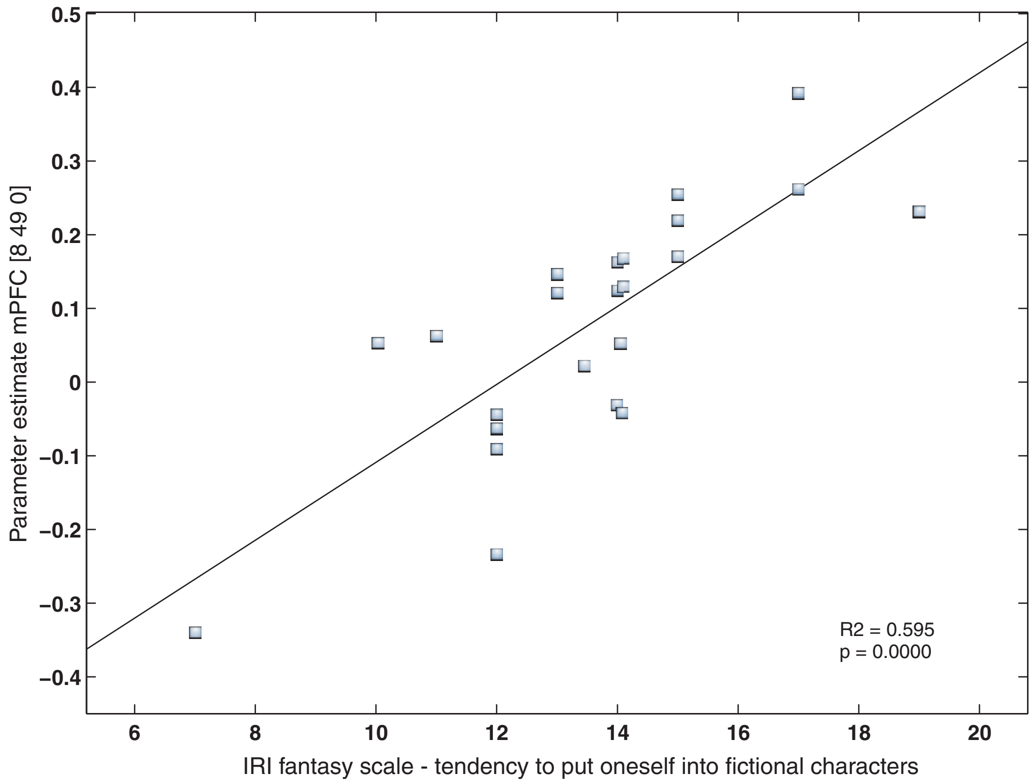


Fig. 2 Positive correlation between the fantasy scale and right FPC—right mPFC connectivity during fiction reading relative to fact reading. The right mPFC showed a stronger coupling with rFPC depending on individual tendency to put oneself into fictional characters.

reading, the reader typically assumes that every word in the text counts and could bear a meaning which might become relevant later (e.g. a knife lying on the kitchen table), a principle also known as Chekhov's gun (see Mar and Oatley, 2008 for further description).

While reading facts seems to elicit mental simulation processes basically regarding actions and their outcomes, reading fiction appears to initiate simulation processes especially concerning the motives behind an action and thereby the protagonist's mind. This interpretation could explain, why large parts of the fiction-activation pattern have been associated previously with social and moral reasoning (Greene *et al.*, 2004; Klucharev *et al.*, 2009), for instance about beliefs and false beliefs (Sommer *et al.*, 2010). According to the latter authors, the evaluation of others' beliefs and false beliefs requires the 'attentive monitoring of a protagonist's behavior' and the 'decoupling between the protagonist's mental state and reality' (Sommer *et al.*, 2010, p. 127). This is also reflected in the PPI pattern we observed with respect to the covariate obtained from the fantasy scale: individuals whose rFPC predicted stronger coupling in the mPFC and rIPL during reading fiction reported a stronger tendency to put themselves into characters of novels and movies. The fantasy scale operationalizes affective empathy which supports the interpretation that the coactivation in the mPFC reflects mentalizing processes. Nevertheless, alternative explanations exist: Ferstl and von Cramon (2002) found the mPFC to be involved in both mentalizing and coherence building during reading and suggested a more general role of the mPFC reflecting the initiation and maintenance of volitional cognitive processes. Further research will be needed to answer the question whether constructive simulation processes during reading fiction go along with ToM-related processing, coherence building or more general integration processes.

The right IPL is especially responsive during the observation and imitation of another person's actions (Decety and Grèzes, 2006; Dinstein *et al.*, 2007), perspective taking (Shane *et al.*, 2009), scene construction (Summerfield *et al.*, 2010) and representation of complex goals (Hamilton and Grafton, 2008). The right IPL seems to be essential for the perception of another person as the agent of an action (Decety *et al.*, 2002; Farrer and Frith, 2002) – moreover the feeling of not being the cause of one's own actions, as reported by a subgroup of schizophrenic patients, was associated with hyper-activation in this region (Farrer *et al.*, 2004). Further in line with our interpretation of fictional reading as a constructive content simulation, the right IPL and the dPCC have been shown to be engaged in thinking about open questions concerning the general- or self-related future (Abraham *et al.*, 2008a).

Taken together, these results for reading stories in a fictional mode are in accordance with the simulation hypothesis (Mar and Oatley, 2008), suggesting a constructive simulation of what might have happened when the events depicted in a text are believed to be fictious.

We observed an activation pattern comprising fronto-parietal control network regions (including FPC, DLPF, dACC) and default mode network regions (IPL, PCC). Interplay of both networks appears to be crucial for internally driven thought (Smallwood *et al.*, 2012) like goal-directed simulations (Spreng *et al.*, 2010; Gerlach *et al.*, 2011). Meaning making requires a balance between inferences upon the text the reader generates via abstraction and association to prior knowledge on the one hand and attentional control to prevent mind wandering away from task (i.e. the text) on the other. It has been shown that frequent mind wandering compromises reading comprehension (Schooler *et al.*, 2004) and leads to longer, uncharacteristic fixations (Reichle *et al.*, 2010). Smallwood *et al.* (2008) reported that too much mind wandering during reading a fictional detective story impaired the construction of a situation model and as such text comprehension. Further investigation will be needed to obtain more insight into the neural processing of reading in a fictional mode, e.g. concerning the relationship between the rFPC and the observed mentalizing regions as the design of our study, especially the PPI analysis, does not allow drawing causal inferences about the precise connections. It might be that the 'better' the simulation processes a story evokes the stronger become mentalizing processes engaged as behavioral studies and the theoretical approach of Mar and Oatley (2008) suggest.

CONCLUSION

In sum, both contexts, the factual and the fictional one, activate processes of imagination but both reflect different levels of simulation (see also Schacter *et al.*, 2008, for an overview). On the one hand, the term *simulation* is used in a broader sense for the representation or inner imitation of actions (see Decety and Grezes, 2006 for a review). Thus, in our study, factual reading would refer to this broader concept of simulation. Fictional reading, on the other hand, seems to represent simulation in the narrower sense of 'imaginative constructions of hypothetical events or scenarios' (Schacter *et al.*, 2008, p. 42). This notion is in keeping with the suggestion of Oatley and Olsen (2010) that factual works relate to the cooperation and alignment of individuals in the real world, whereas fictional works follow primarily the task of imagination and simulation.

SUPPLEMENTARY DATA

Supplementary data are available at *SCAN* online.

REFERENCES

Abraham, A., Schubotz, R.I., von Cramon, D.Y. (2008a). Thinking about the future versus the past in personal and non-personal contexts. *Brain Research*, *1233*, 106–19.

Abraham, A., von Cramon, D.Y., Schubotz, R.I. (2008b). Meeting George Bush versus Meeting Cinderella: the neural response when telling apart what is real from what is fictional in the context of our reality. *Journal of Cognitive Neuroscience*, *20*(6), 965–76.

Addis, D.R., Pan, L., Vu, M.-A., Laiser, N., Schacter, D.L. (2009). Constructive episodic simulation of the future and the past: distinct subsystems of a core brain network mediate imagining and remembering. *Neuropsychologia*, *47*(11), 2222–38.

Amodio, D.M., Frith, C.D. (2006). Meeting of minds: the medial frontal cortex and social cognition. *Nature Reviews Neuroscience*, *7*(4), 268–77.

Buccino, G., Binkofski, F., Fink, G.R., Fadiga, L., Fogassi, L., Gallese, V., et al. (2001). Action observation activates premotor and parietal areas in a somatotopic manner: an fMRI study. *European Journal of Neuroscience*, *13*(2), 400–4.

Calvo-Merino, B., Grèzes, J., Glaser, D.E., Passingham, R.E., Haggard, P. (2006). Report seeing or doing? Influence of visual and motor familiarity in action observation. *Current Biology*, *16*, 1905–10.

Cooper, E.A., Hasson, U., Small, S.L. (2011). Interpretation-mediated changes in neural activity during language comprehension. *NeuroImage*, *55*(3), 1314–23.

Davis, M. (1983). Measuring individual differences in empathy: evidence for a multidimensional approach. *Journal of Personality and Social Psychology*, *44*(1), 113–26.

Decety, J., Chaminade, T., Grèzes, J., Meltzoff, A.N. (2002). A PET exploration of the neural mechanisms involved in reciprocal imitation. *NeuroImage*, *15*(1), 265–72, doi:10.1006/nimg.2001.0938.

Decety, J., Grèzes, J. (2006). The power of simulation: imagining one's own and other's behavior. *Brain Research*, *1079*(1), 4–14.

Decety, J., Jackson, P.L. (2004). The functional architecture of human empathy. *Behavioral and Cognitive Neuroscience Reviews*, *3*(2), 71–100.

Dinstein, I., Hasson, U., Rubin, N., Heeger, D.J. (2007). Brain areas selective for both observed and executed movements. *Journal of Neurophysiology*, *98*(3), 1415–27.

Djikic, M., Oatley, K., Zoeterman, S., Peterson, J. (2009). On being moved by art: how reading fiction transforms the self. *Creativity Research Journal*, *21*(1), 24–9.

Dumontheil, I., Gilbert, S.J., Frith, C.D., Burgess, P.W. (2010). Recruitment of lateral rostral prefrontal cortex in spontaneous and task-related thoughts. *The Quarterly Journal of Experimental Psychology*, *63*(9), 1740–56.

Eco, U. (1994). *Six Walks in the Fictional Woods*. Cambridge: Harvard University Press.

Eippert, F., Veit, R., Weiskopf, N., Erb, M., Birbaumer, N., Anders, S. (2007). Regulation of emotional responses elicited by threat-related stimuli. *Human brain mapping*, *28*(5), 409–23.

Elliot, R., Friston, K.J., Dolan, R.J. (2000). Dissociable neural responses in human reward systems. *The Journal of Neuroscience*, *20*, 6159–65.

Farrer, C., Franck, N., Frith, C.D., Decety, J., Georgieff, N. (2004). Neural correlates of action attribution in schizophrenia. *Psychiatry: Interpersonal and Biological Processes*, *131*, 31–44.

Farrer, C., Frith, C.D. (2002). Experiencing oneself vs another person as being the cause of an action: the neural correlates of the experience of agency. *NeuroImage*, *15*(3), 596–603.

Ferstl, E., von Cramon, D. (2002). What does the frontomedian cortex contribute to language processing: coherence or theory of mind? *NeuroImage*, *17*(3), 1599–612.

Ferstl, E.C., Neumann, J., Bogler, C., von Cramon, D.Y. (2008). The extended language network: a meta-analysis of neuroimaging studies on text comprehension. *Human brain mapping*, *29*(5), 581–93.

Friston, K.J., Buechel, C., Fink, G.R., Morris, J., Rolls, E., Dolan, R.J. (1997). Psychophysiological and modulatory interactions in neuroimaging. *Neuroimage*, *6*(3), 218–29.

Frith, C.D., Frith, U. (2006). The neural basis of mentalizing. *Neuron*, *50*(4), 531–4.

Galak, J., Nelson, L.D. (2010). The virtues of opaque prose: how lay beliefs about fluency influence perceptions of quality. *Journal of Experimental Social Psychology*, *47*(1), 250–253, Elsevier Inc. doi:10.1016/j.jesp.2010.08.002.

Genette, G. (1990). Fictional narrative, factual narrative. *Poetics Today*, *11*(4), 755–74.

Gerlach, K.D., Spreng, R.N., Gilmore, A.W., Schacter, D.L. (2011). Solving future problems: default network and executive activity associated with goal-directed mental simulations. *NeuroImage*, *55*(4), 1816–24.

German, T.P., Niehaus, J.L., Roarty, M.P., Giesbrecht, B., Miller, M.B. (2004). Neural correlates of detecting pretense: automatic engagement of the intentional stance under covert conditions. *Journal of Cognitive Neuroscience*, *16*(10), 1805–17.

Gerrig, R.J., Rapp, D.N. (2004). Psychological processes underlying literary impact. *Poetics Today*, *25*(2), 265–81.

Gilbert, S.J., Spengler, S., Simons, J.S., Frith, C.D., Burgess, P.W. (2006). Differential functions of lateral and medial rostral prefrontal cortex (area 10) revealed by brain-behavior associations. *Cerebral Cortex*, *16*(12), 1783–9.

Goebel, R., Esposito, F., Formisano, E. (2006). Analysis of functional image analysis contest (FIAC) data with brainvoyager QX: From single-subject to cortically aligned group general linear model analysis and self-organizing group independent component analysis. *Human Brain Mapping*, *27*(5), 392–401.

Green, M.C. (2004). Transportation into narrative worlds: the role of prior knowledge and perceived. *Discourse Processes*, *38*(2), 247–66.

Greene, J.D., Nystrom, L.E., Engell, A.D., Darley, J.M., Cohen, J.D. (2004). The neural bases of cognitive conflict and control in moral judgment. *Neuron*, *44*(2), 389–400.

Hamburger, K. (1973). *The Logic of Literature,* 2nd edn. Bloomington: Indiana University Press.

Hamilton, A.F., de, C., Grafton, S.T. (2008). Action outcomes are represented in human inferior frontoparietal cortex. *Cerebral Cortex*, *18*(5), 1160–8.

Han, S., Jiang, Y., Humphreys, G.W., Zhou, T., Cai, P. (2005). Distinct neural substrates for the perception of real and virtual visual worlds. *NeuroImage*, *24*(3), 928–35.

Hasson, U., Nusbaum, H.C., Small, S.L. (2007). Brain networks subserving the extraction of sentence information and its encoding to memory. *Cerebral cortex*, *17*(12), 2899–913.

Hermann, A., Schäfer, A., Walter, B., Stark, R., Vaitl, D., Schienle, A. (2009). Emotion regulation in spider phobia: role of the medial prefrontal cortex. *Social Cognitive and Affective Neuroscience*, *4*(3), 257–67.

Jackson, P.L., Decety, J. (2004). Motor cognition: a new paradigm to study self-other interactions. *Current Opinion in Neurobiology*, *14*(2), 259–63.

Jacobs, A.M. (2011). Neurokognitive Poetik: Elemente eines Modells des literarischen Lesens (Neurocognitive poetics: elements of a model of literary reading). In: Schrott, R., Jacobs, A.M., editors. *Gehirn und Gedicht: Wie wir unsere Wirklichkeiten konstruieren*. München: Carl Hanser Verlag, pp. 492–524.

Klucharev, V., Hytönen, K., Rijpkema, M., Smidts, A., Fernández, G. (2009). Reinforcement learning signal predicts social conformity. *Neuron*, *61*(1), 140–51.

Lamarque, P., Olsen, S.H. (1994). *Truth, Fiction, and Literature. A Philosophical Perspektive*. Oxford: Clarendon.

Mar, R.A. (2011). The neural bases of social cognition and story comprehension. *Annual Review of Psychology*, *62*, 103–34.

Mar, R.A., Kelley, W.M., Heatherton, T.F., Macrae, C.N. (2007). Detecting agency from the biological motion of veridical vs animated agents. *Social Cognitive and Affective Neuroscience*, *2*(3), 199–205.

Mar, R.A., Oatley, K. (2008). The function of fiction is the abstraction and simulation of social experience. *Psychological Science*, *3*(3), 173–92.

Mar, R.A., Oatley, K., Hirsh, J., Delapaz, J., Peterson, J. (2006). Bookworms versus nerds: exposure to fiction versus non-fiction, divergent associations with social ability, and the simulation of fictional social worlds. *Journal of Research in Personality*, *40*(5), 694–712.

McRae, K., Ochsner, K.N., Mauss, I.B., Gabrieli, J.J.D., Gross, J.J. (2008). Gender differences in emotion regulation: an fMRI study of cognitive reappraisal. *Group Processes & Intergroup Relations*, *11*(2), 143–62.

Nieuwenhuys, R., Voogd, J., van Huijzen, C. (2007). *The Human Central Nervous System: A Synopsis and Atlas,* 4th edn. Berlin, Heidelberg: Springer.

Oatley, K., Olson, D. (2010). Cues to the imagination in memoir, science, and fiction. *Review of General Psychology*, *14*(1), 56–64.

Paulus, C. (2009). The Saarbrueck personality questionnaire on empathy: psychometric evaluation of the German version of the interpersonal reactivity index. http://psydok.sulb.uni-saarland.de/volltexte/2009/2363/.

Perani, D., Fazio, F., Borghese, N.A., Tettamanti, M., Ferrari, S., Decety, J., et al. (2001). Different brain correlates for watching real and virtual hand actions. *NeuroImage*, *14*(3), 749–58.

Raichle, M.E., MacLeod, A.M., Snyder, A.Z., Powers, W.J., Gusnard, D.A., Shulman, G.L. (2001). A default mode of brain function. *Proceedings of the National Academy of Sciences of the United States of America, 98*(2), 676–82.

Raposo, A., Vicens, L., Clithero, J.A., Dobbins, I.G., Huettel, S.A. (2010). Contributions of frontopolar cortex to judgments about self, others and relations. *Social Cognitive and Affective Neuroscience*, *6*(3), 260–9.

Reichle, E.D., Reineberg, A.E., Schooler, J.W. (2010). Eye movements during mindless reading. *Psychological Science*, *21*, 1300–10.

Roy, M., Shohamy, D., Wager, T.D. (2012). Ventromedial prefrontal-subcortical systems and the generation of affective meaning. *Trends in Cognitive Sciences*, *16*(3), 147–56.

Schacter, D.L., Addis, D.R., Buckner, R.L. (2008). Episodic simulation of future events: concepts, data, and applications. *Annals of the New York Academy of Sciences*, *1124*, 39–60.

Schooler, J.W., Reichle, E.D., Halpern, D.V. (2004). Zoning out while reading: evidence for dissociations between experience and metaconsciousness. In: Levin, D.T., editor. *Thinking and Seeing: Visual Metacognition in Adults and Children*. Cambridge, MA: MIT Press, pp. 203–26.

Searle, J.R. (1975). The logical status of fictional discourse. *New Literary History*, *6*(2), 319.

Shane, M.S., Stevens, M.C., Harenski, C.L., Kiehl, K.A. (2009). Double dissociation between perspective-taking and empathic-concern as predictors of hemodynamic response to another's mistakes. *Social Cognitive and Affective Neuroscience*, *4*(2), 111–8.

Singer, T., Seymour, B., O'Doherty, J.P., Stephan, K.E., Dolan, R.J., Frith, C.D. (2006). Empathic neural responses are modulated by the perceived fairness of others. *Nature*, *439*(7075), 466–9.

Smallwood, J., Brown, K., Baird, B., Schooler, J.W. (2012). Cooperation between the default mode network and the frontal-parietal network in the production of an internal train of thought. *Brain research*, *1428*, 60–70, Elsevier B.V. doi:10.1016/j.brainres.2011.03.072.

Smallwood, J., McSpadden, M., Schooler, J.W. (2008). When attention matters: the curious incident of the wandering mind. *Memory & Cognition*, *36*(6), 1144–50, doi:10.3758/MC.36.6.1144.

Smith, M. (2009). Double trouble: on film, fiction, and narrative. *StoryWorlds: A Journal of Narrative Studies*, *1*(1), 1–23.

Sommer, M., Meinhardt, J., Eichenmüller, K., Sodian, B., Döhnel, K., Hajak, G. (2010). Modulation of the cortical false belief network during development. *Brain Research*, *1354*, 123–31.

Spreng, R.N., Stevens, W.D., Chamberlain, J.P., Gilmore, A.W., Schacter, D.L. (2010). Default network activity, coupled with the frontoparietal control network, supports goal-directed cognition. *NeuroImage*, *53*(1), 303–17, Elsevier Inc. doi:10.1016/j.neuroimage.2010.06.016.

Summerfield, J.J., Hassabis, D., Maguire, E.A. (2009). Cortical midline involvement in autobiographical memory. *NeuroImage*, *44*(3), 1188–200.

Summerfield, J.J., Hassabis, D., Maguire, E.A. (2010). Differential engagement of brain regions within a "core" network during scene construction. *Neuropsychologia*, *48*(5), 1501–9.

Talairach, J., Tournoux, P. (1988). *Co-planar Stereotaxic Atlas of the Human Brain*. New York: Thieme.

Tricomi, E., Rangel, A., Camerer, C.F., O'Doherty, J.P. (2010). Neural evidence for inequality-averse social preferences. *Nature*, *463*(7284), 1089–91.

van Dijk, T.A., Kintsch, W. (1983). *Strategies of Discourse Comprehension*. New York: Academic Press.

Whitehead, C., Marchant, J.L., Craik, D., Frith, C.D. (2009). Neural correlates of observing pretend play in which one object is represented as another. *Social cognitive and affective neuroscience*, *4*(4), 369–78.

Willems, R.M., Clevis, K., Hagoort, P. (2010). Add a picture for suspense: neural correlates of the interaction between language and visual information in the perception of fear. *Social Cognitive and Affective Neuroscience*, *6*(4), 404–16.

Woolley, J.D., Cox, V. (2007). Development of beliefs about storybook reality. *Developmental Science*, *10*(5), 681–93.

Woolley, J.D., Wellman, H.M. (1990). Young children's understanding nonrealities, and appearances of realities. *Child Development*, *61*(4), 946–61.

Xu, J., Kemeny, S., Park, G., Frattali, C., Braun, A. (2005). Language in context: emergent features of word, sentence, and narrative comprehension. *NeuroImage*, *25*(3), 1002–15.

Yarkoni, T., Speer, N.K., Zacks, J.M. (2008). Neural substrates of narrative comprehension and memory. *NeuroImage*, *41*(4), 1408–25.

Zink, C.F., Pagnoni, G., Martin, M.E., Dhamala, M., Berns, G.S. (2003). Human striatal response to salient nonrewarding stimuli. *Journal of Neuroscience*, *23*(22), 8092–7, http://www.ncbi.nlm.nih.gov/pubmed/12954871.

Zwaan, R.A. (1994). Effect of genre expectations on text comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *20*(4), 920–33.

3.1. Supplementary data

Table S1	Brain activation for the conjunction of reading facts and reading fiction						
				Talairach Coordinates			
Cluster size	Region	BA		X	Y	Z	Max. t-value
7517	Lingual Gyrus	18	R	12.0	-79.0	-5.0	36.25
	Lingual Gyrus	18	L	-12.0	-79.0	-5.0	20.28
	Lingual Gyrus	17	L	-21.0	-91.0	-2.0	16.58
	Cerebellum	-	L	-27.0	-76.0	-14.0	15.04
	Precentral Gyrus	4	L	-48.0	-7.0	43.0	13.87
	Middle Temporal Gyrus	22	L	-54.0	-10.0	-5.0	12.50
	Cerebellum	-	L	-39.0	-64.0	-14.0	11.58
	Middle Temporal Gyrus	22	L	-54.0	-34.0	4.0	11.45
	Superior Temporal Gyrus	38	L	-48.0	8.0	-14.0	10.94
	Middle Occipital Gyrus	19	L	-24.0	-85.0	13.0	10.83
	Cerebellum	-	L	-12.0	-55.0	-2.0	8.49
	Inferior Frontal Gyrus	47	L	-45.0	26.0	-2.0	8.34
	Fusiform Gyrus	37	L	-36.0	-43.0	-14.0	7.69
	Thalamus/Lateral Geniculum Body	-	L	-21.0	-25.0	-2.0	6.96
	Middle Occipital Gyrus	18	R	21.0	-85.0	16.0	6.77
	Inferior Frontal Gyrus	45	L	-48.0	20.0	16.0	6.61
	Parahippocampal Gyrus/Amygdala	-	L	-21.0	-10.0	-14.0	5.02
761	Superior Temporal Gyrus	21/22	R	48.0	-10.0	-11.0	10.42
	Superior Temporal Gyrus	38	R	45.0	11.0	-17.0	8.86
	Insula	22	R	42.0	-22.0	-5.0	7.19
	Superior Frontal Gyrus	11	R	24.0	41.0	-23.0	4.25
155	Inferior Frontal Gyrus	45	R	54.0	20.0	22.0	6.34
71	Medial Frontal Gyrus	6	L	-6.0	-1.0	58.0	5.94
40	Thalamus/Medial Geniculum Body	-	R	18.0	-25.0	-2.0	5.66
	Parahippocampal Gyrus*	35	R	24.0	-25.0	-17.0	3.62
109	Medial Frontal Gyrus	9	L	-6.0	50.0	34.0	4.60
	Superior Frontal Gyrus	8	L	-9.0	47.0	46.0	4.37
	Superior Frontal Gyrus*	8	R	9.0	44.0	43.0	3.41
48	Precentral Gyrus	4	R	60.0	-7.0	28.0	4.23
23	Parahippocampal Gyrus/Amygdala	-	R	21.0	-10.0	-14.0	4.21
9	Cerebellum**	-	R	3.0	-46.0	-32.0	4.14
27	Precentral Gyrus*	4	R	48.0	-13.0	52.0	3.35
	Precentral Gyrus**	4	R	39.0	-19.0	61.0	3.29
9	Medial Frontal Gyrus**	10	L	0.0	44.0	-11.0	3.02

Table S1. Brain activation during reading (fact AND fiction) Region, Talairach coordinates, and t-score for the peak voxel of significantly activated regions; corrected for multiple comparisons at cluster level ($P < .05$) with an initial voxel level threshold of $p < .001$ (uncorrected). At an initial voxel level threshold of $p < 0.003$* and $p < 0.005$** (uncorrected) additional regions became engaged.

Chapter 4.

Beyond beauty - Art as a canvas to social cognition, an fMRI study

This chapter is under review as

Altmann, U., Jacobs, A. M., Wilke, S., & Leder, H. (2017). *Beyond Beauty - Art as a canvas to social cognition, an fMRI study*. Article under review.

4.1 Introduction

Art production and appreciation are essential aspects of human culture. For centuries, aesthetic experience has been debated in philosophy, often associated with beauty and sensory pleasure of art (Baumgarten, 1750). Recently, neurobiological studies began to reveal the neural processes underlying the perception and response to art and beauty (Chatterjee, 2011; Chatterjee & Vartanian, 2014). Neuroimaging studies found that preference and beauty ratings of artworks are associated with activation in prefrontal areas (Cela-Conde et al., 2004), especially in the orbito-frontal cortex (OFC, BA 11), anterior cingulate cortex (ACC, BA 32), striatum, and occipital cortex (Kawabata & Zeki, 2004; Vartanian & Goel, 2004).

Although beauty perception and beauty judgments are, in themselves, interesting issues, the appreciation of art goes far beyond the notion of beauty (Bundgaard, 2014; Leder et al., 2004). For instance, disturbing and unpleasant artworks can be perceived highly interesting (Turner & Silvia, 2006) and abstract art can be appreciated for its ambiguity (Jakesch and Leder, 2009). The median of time people spend on viewing an artwork in a museum varies between 11 and 38.8 seconds before the attention is turned to another piece of artwork (Brieber et al., 2014; Smith & Smith, 2001). Viewing times for artworks in a museum however cannot (Heidenreich and Turano, 2011), or at least not alone (Brieber et al., 2014), be explained by aesthetic enjoyment.

In settings in which art is commonly seen, as in museums or galleries, the aesthetic experience is generally driven by self-directed and often implicit cognitive and emotional processes (Leder et al., 2004). Goal-oriented explicit evaluations, as in making quantitative aesthetic judgments of beauty, seems the exception rather than the rule to the experience of art (Ball, 2013; Cela-Conde et al., 2011). This is clearly acknowledged in discourses on contemporary art in which artworks "[...] are as likely to be discussed in terms of *what* they show, and what those subjects signify, than in terms of how "pleasing" they might be to human senses" (Gopnik, 2012, p. 134). Correspondingly, several philosophers and psychologists emphasized mentalizing and empathic engagement to be crucial aspects of aesthetic experience (Lipps, 1903;

see Currie, 2011; Freedberg & Gallese, 2007; Hirstein, 2013) while others stressed a detached approach to experiencing an aesthetic object (Kant, 1790/2001; Collingwood, 1938).

However, so far, such processes have rarely been examined in neuroscientific studies on visual aesthetics. We assume that mentalizing and empathic engagement, e.g., are more likely to unfold if participant's attention during art perception is not focused on the explicit judgment and the respective decision they are requested to provide. Disinterestedness has been frequently accentuated a crucial characteristic of aesthetic experience (Leder et al., 2004; Leder et al., 2014). Initially, the engagement with art is not tied to action relevance. In other words, the journey is the reward. On this account the self-reinforcing aesthetic experience might be sensible to task related-external affordances like the action of communicating a judgment. Therefore, here, we investigate the aesthetic experience of visual art in a free viewing mode and compare it to a judgment-oriented viewing of artworks.

4.1.1. Implicit processing of artworks

A small number of neuroscientific studies investigated questions in the domain of art, without instructing the beholder to provide explicit beauty or liking ratings instantaneously during scanning (for a review, see Kühn & Gallinat, 2012) but asked participants for instance to evaluate the content of pictures with respect to animacy (Lacey et al., 2011) or familiarity (Fairhall and Ishai, 2008).

Studies contrasting the spontaneous observation of canonical sculptures with an explicit aesthetic judgment condition revealed the spontaneous hedonic neural response to be associated with activation in the right anterior Insula (AI) (Di Dio et al., 2007, 2011).

Cupchik et al. (2009) instructed participants to view paintings either in a detached manner with a focus on the content or in an aesthetic, more self-related manner, focussing on colours and composition as well as on the experience of evoked moods and feelings. Thereby, the authors refrained from collecting any behavioral measures during the scanning procedure. They found activation in the lateral PFC during the self-referential contemplation of artworks and interpret them to reflect maintaining attention on internally generated cognitions.

Similarly, Höfel and Jacobsen (2007) reported a lateralized late positivity when participants were instructed to reflected about beauty in geometrical patterns but were not asked to provide an explicit aesthetic judgment. As the authors could not observe a similar EEG signal when they asked participants to merely view the stimuli they concluded that the aesthetic engagement does not occur automatically but instead requires an explicit intention.

Vessel and colleagues (2012) asked the participants of their study to give recommendations to an (imagined) fictitious curator by indicating the strength by which a painting was moving them. In addition to activations reflecting the sensory and emotional processing, the most moving artworks lead to activations including the medial prefrontal cortex (mPFC), the posterior cingulate cortex (PCC), and the temporoparietal junction (TPJ); known as core regions of the default mode network (DMN) and associated with self-referential thinking. Accordingly, the authors concluded personal relevance to be an integral part of the aesthetic experience.

Models of visual aesthetics focus on the complex interplay of early visual encoding steps and various cognitive and emotional processes in response to artworks (Chatterjee, 2004; Chatterjee & Vartanian, 2014; Leder & Nadal, 2014; Leder, Markey & Pelowski, 2015). In their review paper, Leder and Nadal (2014) in accordance with others (Shusterman, 1997; Begeron & Lopez, 2012) identified three components determining an aesthetic experience "(1) An aesthetic experience has an evaluative dimension, in the sense that it involves the valuation of an object; (2) it has a phenomenological or affective dimension, in that it is subjectively felt and savoured and it draws our attention; (3) it has a semantic dimension, in that an aesthetic experience is a meaningful experience, it is not mere sensation." (p.445). These elements are accounted for in the 'aesthetic triad' outlined by Chatterjee and Vartanian (2014) in a recent review of the aesthetic neuroscience literature. Thus, the aesthetic experience emerges from the interplay of sensory-motor, emotion-valuation and knowledge-meaning systems.

4.1.2. The present study: free viewing *versus* aesthetic evaluation

In the present study, we performed an fMRI experiment aimed at learning about the neural processing of artworks in situations that do not demand explicit evaluations. We presented a number of paintings to participants for 6 seconds each, and tested two experimental conditions: In the *explicit judgment condition* participants were aware that they would be subsequently asked to evaluate the presented artwork with respect to liking, On the contrary, in the *free viewing condition* participants were informed that no decision on a judgment had to be made.

With respect to the (1) *explicit judgment* condition, we predicted that the decision-making requirements of explicit liking-judgments would shape the prior perception of paintings in terms of an evaluation related processing (e.g., reflected in activation of the OFC, ACC and DLPFC), although participants were asked to make their judgment 4-8 seconds *after* the presentation of a painting. Of main interest was the neural processing of paintings in the (2) *free viewing* condition (relative to the *explicit judgment* condition). Models of aesthetic appreciation (Leder et al. 2004; Cela-Conde et al., 2011) suggest that the *free viewing* of paintings should be mainly driven by a need for understanding and associated self-related interpretation. Therefore in this condition we expected stronger activation of brain regions that are known to be part of the DMN and involved in self-referential processing, especially the medial prefrontal cortex (mPFC) and the posterior cingulate cortex (PCC) (Nordhoff & Bermpohl, 2004; Kreplin & Fairclough, 2015; Mitchell et al., 2005; Spreng, 2012; Vessel et al., 2012). However, due to the lack of a task directly linked to the presentation of paintings, it is also conceivable that the mind of the participants might wander and drift away from the stimulus (Buckner et al., 2008).

4.2. Materials and Methods

4.2.1. Stimuli

The study material consisted of 120 paintings representing a variety of artists (Marc Chagall, René Magritte, Édouard Manet, Claude Monet, Rembrandt van Rijn, Pierre-Auguste Renoir, Vincent van Gogh, and Jan Vermeer) and artistic styles (baroque, impressionism, expressionism, and surrealism). The selected artworks included paintings depicting one or more human subjects with clearly recognizable faces (49%), paintings depicting figures but no clearly recognizable faces (27%) or figures subtly in the background (13%), as well as landscapes or still lifes (19%). A complete list is available from the authors on request. In order to avoid potential memory effects a pre-study was conducted, which made sure that the paintings chosen were relatively unknown to non-experts.

4.2.2. Participants

Twenty-four healthy, right-handed volunteers (12 female, mean age: 23; age range: 18–31) took part in the study. Participants were German native speakers and non-professionals in art. All participants had normal or corrected to normal vision and gave informed written consent in accordance with the local research ethics committee of the Freie Universität Berlin.

4.2.3. Procedure

Using a within-subject design, we assessed the neural responses of 24 participants to 120 unfamiliar paintings by various famous artists. All participants beheld the same 120 paintings where the presentation of artworks was pseudo-randomized across runs and conditions (*explicit judgment, free viewing*). The two task conditions (*explicit judgment, free viewing*) alternated pseudo-randomized across subjects in blocks of 15 paintings; half of the participants started the experiment with the free viewing task, the other half started with the explicit judgment task, respectively.

Following the presentation of each painting (6 seconds), one of two button press conditions appeared after 4-8 seconds, pseudo-randomly jittered using a Poisson-distribution (Figure 4.1).

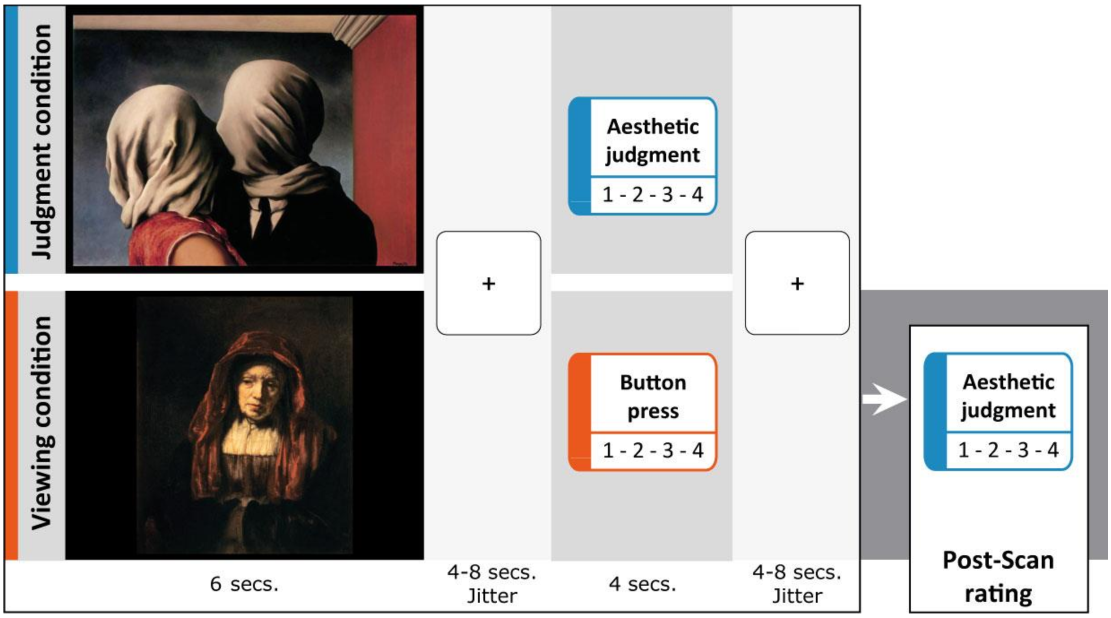


Figure 4.1. Study design.

Note. A total of 120 paintings representing a variety of artists and artistic styles were presented, 60 in each task condition (explicit *judgment, free viewing*). The two task conditions alternated in blocks of 15 artworks. All participants saw exactly the same paintings, only the corresponding task condition was pseudo-randomized across subjects. The presentation of paintings (6 seconds), prior to button-press responses, was used as the time period of interest for functional data analysis.

In the *explicit judgment* condition, participants had to indicate via trackball, on a four-point rating scale, how much they liked the painting. In the *free viewing* condition, no evaluation was required. To keep the motor activity identical, in this condition a four-point scale also followed the presentation of each painting, but the button participants had to press was displayed (in pseudorandom order) above the scale.

After the scanning session, supplemental liking ratings for all paintings that had been presented in the *free viewing* condition were obtained from the participants. This allowed us to examine (1), whether the participant's liking judgments were modulated depending on task or whether they constitute task-independent evaluations. In a post-test session participants were asked to complete the interpersonal reactivity index (IRI, Davis, 1983; German version: Paulus, 2009) which provides a four-dimensional self report estimate of empathy. In the current study, we focus on the 'fantasy' subscale which asses the individual tendency to put oneself into fictional characters, because the disposition to become absorbed in art, literature or film was found to be associated with increased preference and attribution of personal meaning in response to complex composite artworks (Cupchik & Gignac, 2007).

Fantasy scores showed a mean of 12.89 and a standard deviation of 3.05 (corresponding mean of German population norms = 14.56, SD = 2.94; norm data retrieved from Paulus,C., "Normtabellen des SPF", last modified November 21, 2011, http://bildungswissenschaften. uni-saarland.de/personal/paulus/empathy/Normen.pdf).

4.2.4. fMRI data acquisition

Functional data were acquired on a Siemens Tim Trio 3T MR imager using a 12 channel head coil. Individual high-resolution T1-weighted anatomical data (MPRAGE sequence) were acquired (176 slices; FOV, 256; TE, 2.52 ms; TR, 1.9 s; matrix, 256 × 256; resolution 1.0 × 1.0 × 1.0 mm; sagittal plane; slice thickness, 1 mm).

Four runs of 410 volumes were measured using a T2* weighted echo-planar sequence (slice thickness, 3 mm; no gap; 37 slices; repetition time (TR), 2 s; echo time (TE), 30 ms; flip angle, 90°; matrix, 64 × 64; field of view (FOV), 192 mm; voxel-size 3.0 × 3.0 × 3.0 mm). Images were presented using Presentation software 14.9 (Neurobehavioral Systems, Albany, Canada) and were rear-projected onto a mirror mounted on the head coil.

4.2.5. Data analysis

Behavioral measures were analyzed with SPSS (SPSS Inc., Chicago, IL, USA). Analysis of fMRI data was conducted with Brain Voyager QX [2.0] (Brain Innovation, Maastricht, The Netherlands; Goebel et al., 2006). Functional data were corrected for head motion and for different slice scan times using cubic spline interpolation. To remove low-frequency signal drifts, a high-pass filter was applied with a cutoff period three times the block length. Spatial smoothing was performed using a Gaussian filter of 8 mm, full width at half maximum. The functional maps of each participant were then transformed into standard Talairach space (Talairach & Tournoux, 1988).

Whole-brain statistical analysis was performed according to the general linear model as implemented in Brain Voyager QX. On the first level, the model was generated with two blocked regressors for the presentation of paintings (*explicit judgment* condition, *free viewing* condition) and two blocked regressors for the task period (preference rating and button-press task periods). Individual contrast images from the first-level analysis were applied to a second-level random effects group analysis, in which we tested the presentation of paintings for the main effect of condition (*explicit judgment* vs. *free viewing*). In addition to this first model, a second model was constructed. It included an additional parametric regressor containing the individual aesthetic judgments given by our participants for every painting (one half of these judgments was collected inside the scanner, the other half was collected after the scanning procedure). We defined this model in order to test for brain responses that increase during the perception phase with increasing aesthetic judgments. In addition to common parametric effects, we also tested for possible differences in brain responses that predict higher liking judgments between both experimental conditions (*explicit judgment* vs. *free viewing*). The main contrasts were reported whole-brain corrected ($p < .05$) using false discovery rate (FDR), and with an extend threshold of $k = 10$ voxels for the resulting clusters.

In correspondence with our initial hypotheses we identified the ventromedial prefrontal cortex (vmPFC) to be involved in the free contemplation of artworks and selected it as seed region for further psychophysiological interaction (PPI) analysis (Friston et al., 1997) using NeuroElf (http://neuroelf.net) with a sphere of 10mm around the peak voxel (0, 56, 1). PPI analysis allows identifying brain regions that show a stronger coactivation during one task (free viewing) as compared to another (explicit judgment). Particularly we were interested in whether vmFPC activation specific to the task-free viewing of paintings is “coupled” with ToM related brain areas like the medial PFC, TPJ and PCC. The psychophysiological interaction regressor was calculated as the element-by-element product of the mean corrected activity in the vmPFC region of interest and the task vector coding for the context specific effect of free viewing compared to the explicit judgment condition. To identify areas of the brain that showed increased activation during free viewing when vmPFC activation increased, individual PPI regressors where entered into a second level random effects analysis. Individual scores on the fantasy scale served as a covariate to examine areas of the brain that showed a stronger coupling with vmFPC depending on individual tendency to put oneself into fictional characters. The PPI results were corrected for multiple comparisons ($p < .05$) at the cluster level using Monte Carlo simulations in order to calculate minimum cluster-size thresholds (initial threshold at the voxel level $p < .001$ uncorrected).

4.3. Results

4.3.1. Behavioral results

We started the data analysis with an inspection of the behavioral measures. A repeated measures ANOVA was conducted to examine whether the participant's liking judgments were modulated depending on task or whether they constitute task-independent evaluations. Analysis of the liking ratings revealed no difference between judgments assessed inside and those assessed outside the scanner ($F(1,23)=.18$, $p=.677$, eta2=.008). Hence, the aesthetic judgments of our participants were not modulated by task (*explicit judgment*, *free viewing*) or time of assessment (direct rating of each painting after presentation inside the scanner, post-scan rating outside of the scanner).

4.3.2. fMRI results

4.3.2.1. Parametric effects of liking

First, it was analyzed whether brain activity during art perception predicted participants' liking judgments obtained either inside or outside the scanner. We found increased activation in the OFC (BA 11), the ventral striatum, the occipital cortex (BA 18/19) and the superior parietal cortex (BA 7) predicting higher liking ratings (Figure 4.2; Table 4.1 presents findings for brain activations that predict subsequent liking judgments).

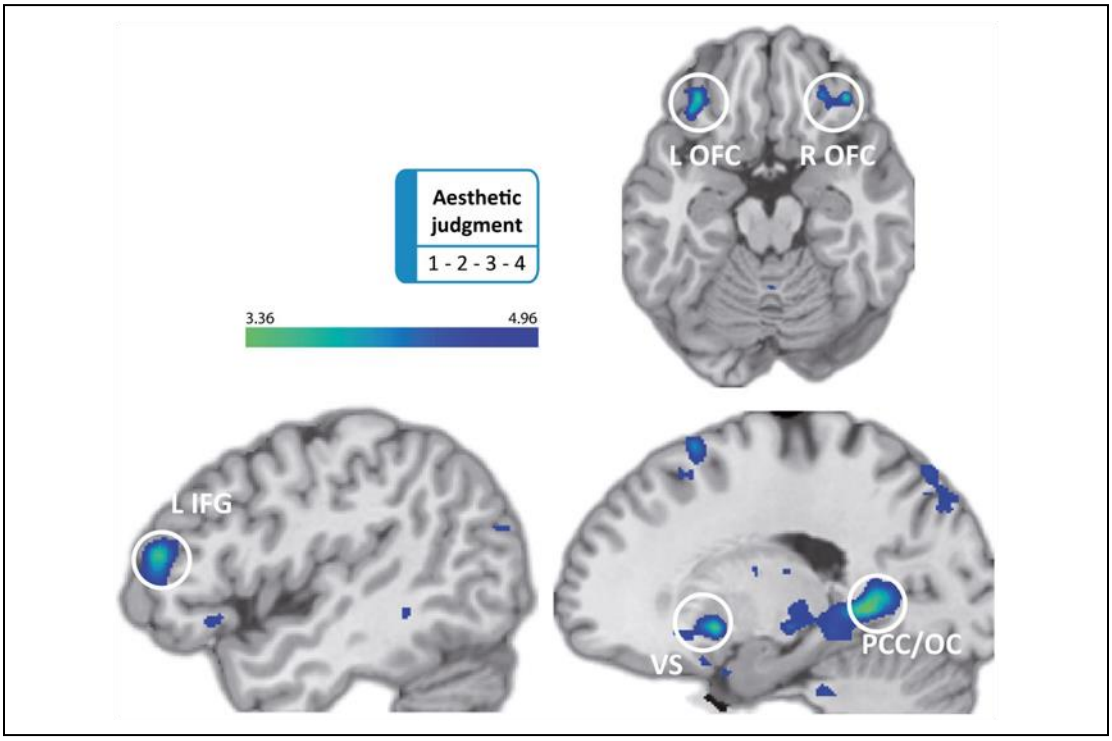


Figure 4.2. Brain activation during art perception predicting participants' aesthetic judgments.

Note. Brain responses that increase during the perception of artworks with increasing aesthetic judgments obtained either inside the scanner (explicit judgment) or post-scan (free viewing): OFC [27 35 -20; -33 35 -20], ventral striatum [-18 8 -8] and the PCC/occipital cortex [21 -55 16; -15 -49 -2]. Data are whole-brain corrected using false discovery rate (FDR, $P < 0.05$), minimum cluster size 10 voxels ($k = 10$).

The direct comparison of the free viewing with the explicit judgment condition elicited no significant differences regarding the parametric modulation of liking. On a less conservative threshold, however (corrected for multiple comparisons at cluster level $p < .05$ with an initial voxel level threshold of $p < .001$, uncorrected), the analysis yielded a stronger relationship between judgments of liking and the lateral OFC (BA 11), the lateral occipital cortex (LOC) and the right fusiform gyrus (FG, BA 37) during task-free viewing relative to the explicit judgment condition. The reverse contrast revealed activations in the middle frontal gyrus (BA 10, 11), DLPFC (BA 9), ACC (BA 32) and anterior insula (AI, BA 13) (Table 4.2 presents findings for brain activations that predict subsequent liking judgments in the free viewing condition relative to the explicit judgment condition).

4.3.2.2. Explicit Judgment

Next, we contrasted brain activity during the *explicit judgment* condition and the *free viewing* condition (Figure 4.3a; Table 4.3 presents findings for brain responses during the explicit judgment condition compared to free viewing of paintings). Explicit evaluations led to greater activation in the bilateral OFC (BA 11), bilateral inferior frontal gyrus (IFG, BA 44/47), dorsolateral prefrontal cortex (DLPFC, BA 10/46) and anterior Insula (AI, BA 13), dorsal anterior cingulate cortex (dACC, BA 32), bilateral fusiform gyrus (BA 37), and PCC (BA 23).

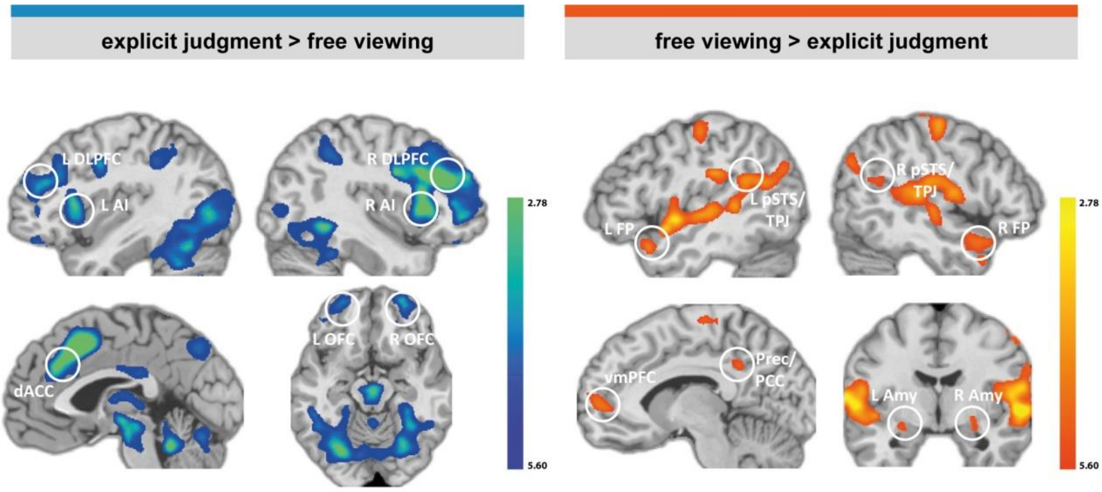


Figure 4.3. Brain areas activated when comparing the free viewing condition with the explicit judgment condition.

Note. a. Areas of selective activation for the contrast explicit judgment vs. free viewing (cold colors). In the explicit judgment condition the perception of artworks engaged neural responses associated with judgment-oriented decision making: OFC [27 56 -17; -24 50 -20], dlPFC [45 29 22], dACC [-9 26 31] and AI [36 20 4; -27 20 10]. **b.** Areas of selective activation for the contrast free viewing vs. explicit judgment (warm colors). Free viewing of artworks engaged the affective mentalizing network: vmPFC/ACC [0 56 1], amygdala [27 -10 -11; -24 -4 -14], pSTS/TPJ [63 -46 16; -48 -58 19], PCC [31 -12 46]. Data are whole-brain corrected using false discovery rate (FDR, $P < 0.05$), minimum cluster size of 10 voxels ($k = 10$).

4.3.2.3. Free viewing

Not only did the *free viewing* condition in the reverse contrast elicited stronger activity in the ventromedial prefrontal cortex (vmPFC/ACC, BA 10) and PCC/Precuneus (BA 31) as predicted, but also in brain areas that are typically associated with the core affective mentalizing network, including bilateral activations in the temporal poles (TP, BA 38), the amygdala and posterior superior temporal sulcus/temporoparietal junction (pSTS/TPJ, BA 22/39) (Figure 4.3b; Table 4.4 presents findings for brain responses during the free viewing of paintings compared to the explicit judgment condition).

4.3.2.4. PPI analysis

By means of a PPI analysis, we examined which areas of the brain showed stronger functional connectivity with vmPFC during the free viewing of artworks, depending on self-report scores at the fantasy scale [cluster level corrected ($p < .05$), initial voxel level threshold $p < .001$ uncorrected]. Individuals who reported a stronger tendency to put themselves into characters of novels and films showed a stronger coupling between vmFPC and the ACC (BA 24/32), left IFG (BA: 47), left amygdala, left frontopolar cortex (FPC, BA 10), DLPFC (BA 46), PCC (BA 31), Precuneus (BA 7) and also [cluster level corrected ($P < .05$), initial voxel level threshold $p < .005$ uncorrected] in the left dorsal anterior Insula (BA 13) (Table 4.5).

4.4. Discussion

The purpose of the current study was to investigate the neural response to unfamiliar paintings of commonly known artists depending on whether the presentation phase was followed by an overt liking judgment (explicit judgment condition) or not (free viewing condition). Our main finding indicates that during the *free viewing* condition participants not only processed the paintings in a self-referential manner as hypothesized, but that they also engaged in affective mentalizing processes. In contrast and in correspondence with our initial hypothesis our data indicate that the viewing of paintings in the explicit judgment condition was shaped by the anticipation of the following judgment phase in the form of reward and decision related processing.

4.4.1. Effect of task (explicit judgment, free viewing) on the predictability of later liking judgments

Regardless of condition (explicit judgment, free viewing), a parametric analysis was conducted to test for linear relationships between regional changes in the BOLD signal during the viewing of artworks and obtained liking judgments.
Liking-dependent signal changes emerged in brain regions known to be involved in the perceptual analysis (occipital cortex, superior parietal cortex) and reward processing (OFC, ventral striatum). These data resemble previous findings of studies that investigated the neural foundations underlying evaluations of liking, pleasure or beauty with respect to artworks (Cela-Conde et al., 2011; Kawabata & Zeki, 2004; Kühn & Gallinat, 2012; Nadal, 2013; Vartanian & Goel, 2004).

The results of the behavioral data suggest that the liking judgment was unaffected by the time of assessment (inside the scanner or post-scan), which is in line with previous findings (Höfel & Jacobsen, 2007; Kawabata & Zeki, 2004; Lacey et al., 2011). Correspondingly, evidence from a meta-analysis on the neural foundation of subjective pleasantness indicates an automatic evaluation of likability "that is neither elicited nor enhanced by instructions to report the outcome of these judgments" Kühn and Gallinat, 2012, p. 289.

To examine this more closely, we also tested for different parametric effects for the free viewing relative to the aesthetic judgment condition. Initially, the parametric effect of liking revealed no significant differences regarding the time of assessment; that is to say, very similar brain responses showed to be predictive of the upcoming liking judgment, irrespective of whether this was obtained announced and directly in the scanner or later, unannounced during the post-scan rating phase.

However, on a less conservative threshold our data revealed a stronger neural relationship with later liking judgments in the fusiform gyrus and the LOC during free viewing relative to the explicit judgment condition. Both regions play an important role in processing faces and body parts (Peelen & Downing, 2005); especially faces in artworks depicting social interactions attract the viewers eye movements (Villani et al., 2015). The automatic increase of activation in the FG and LOC in response to parametric increases of liking is concordant with data from the literature. In a study on facial attractiveness (Chatterjee et al., 2009) participants either had to provide an overt judgment or to indicate whether two faces were identical. Although an aesthetic evaluation was not relevant for the latter task a related neural response was elicited in the LOC and the FG. Similarly, Lacey and colleagues (2011) asked their participants to make animate/inanimate decisions upon art and non-art images. Here again, although an elaboration of the images on beauty was irrelevant to the task, the authors found the LOC and FG to be modulated by beauty and liking gathered later in a post-scan rating. Interestingly, this effect could be observed for artworks but not for non-art stimuli suggesting that it might be exclusively related to the domain of aesthetics. This appears to be only partially the case. Morelli and Lieberman (2013) compared intentional empathizing and free watching of photos depicting happy people. Both conditions revealed common neural activations involved in empathic processing but the task-free watching of photos evoked additional neural responses in the FG and LOC. We therefore speculate that the stronger parametric modulation of the FG and the LOC during free viewing of paintings in our study may be related to more attention resources available in that condition and consider it likely that the lower cognitive load, compared to the explicit judgment condition, allows for a more extensive visual analysis of the paintings (most of them depicting clearly recognizable faces or figures). The absence of affordances to pursue and monitor an external goal might allow for the self-regulated direction of attention according to the beholders (disinterested) interest. This fits into the model of visual aesthetics provided by Leder et al. (2004; see also Leder and Nadal, 2014) that postulates continuous feedback-loops between perceptual, affective and semantic processing steps in the course of 'mastering' an artistic object. The specific role of FG and LOC during the automatic evaluation of likability cannot be determined from this study alone and should be subject to further research.

4.4.2. Judgment oriented processing of paintings

Appreciating artworks when knowing that an aesthetic judgment would be required engaged activation in the OFC, dACC, and AI; related to the processing of rewarding stimuli and consistently reported for the evaluation of subjective pleasantness (Cupchik et al., 2009; Di Dio et al., 2007, 2011; Ishizu and Zeki, 2011; Kawabata and Zeki, 2004; Kirk, 2008; Kühn and Gallinat; 2012). The AI has not only been observed to accompany an aesthetic viewing mode (Cupchik et al., 2009) as well as the processing of classical sculptures (Di Dio et al., 2007, 2011). Together with the dACC, the AI is also known to be a part of the frontoparietal control network (FPN) that we found to complement the aforementioned activation pattern, including the ventrolateral prefrontal cortex (vlPFC), the DLPFC, and the Precuneus. It has been suggested (Smallwood et al., 2012) that internally driven thought like goal-directed cognition (Spreng et al., 2010) depends on the interplay of FPN and DMN regions (IPL, PCC), also involved in the *explicit judgment* condition.

Hence, our data suggest that the participants in our study already started to evaluate the paintings during the observation period thus preparing for the upcoming judgment. Tasks, which require the attention and handling of self-produced information, as for the anticipation of a future liking judgment, regularly engage the lateral PFC (Dumontheil et al., 2010). This provides a possible explanation for our data, suggesting that the contemplation of liking or disliking dominates the neural response to artworks in the *explicit judgment* condition. Correspondingly, activation of the DLPFC has been observed to modulate the aesthetic appreciation of artifacts (Cattaneo et al., 2013; Cela-Conde et al., 2004; Nadal, 2013; Vessel et al., 2012) and top-down control driven by the DLPFC, for example, accompanied aesthetic relative to pragmatic viewing of artworks (Cupchik at al., 2009).

4.4.3. Task-free processing of paintings

In contrast to the explicit judgment condition the free viewing condition was not linked to an evaluation related task following the presentation of the artworks - the participants were merely asked to press a predefined button. We expected that the free viewing of artworks would trigger introspective self-referential evaluations of the percepts reflected by activation in the mPFC and PCC (Vessel et al., 2012).

However, the activation pattern we observed - comprising the vmPFC and the PCC as hypothesized, but also the TP, TPJ, and the amygdala - indicates that participants not only processed the paintings in such a self-referential manner, but that they also engaged in affective mentalizing processes (Schnell et al., 2011; Sebastian et al., 2012; Walter, 2012). Our data suggest that non-experts try to infer *what* is expressed in an artwork (Leder et al., 2014) and that they use their social processing skills, for example, to read out affective signals in order to understand the mental states of the persons/figures depicted in a visual scene (Cela-Conde et al., 2011).

The vmPFC is connected to brain areas involved in affective processing (e.g. amygdala and TP) and consistently linked to affective mentalizing, as it integrates information about the self or others. (Sebastian et al., 2011; Schnell et al. 2010; Shamay-Tsoory, 2011). Considering its highly integrative capacity, the vmPFC has been conceptualized a key node for the representation, understanding and evaluation of situations on a more general level, thus providing affective meaning (Roy et al., 2012). In line with this approach, we believe that the activation pattern evoked during the task-free viewing of paintings reflects the individuals attempt to grasp a meaning of the artworks.

Support for this interpretation is provided by the literature. It has been demonstrated that the medial PFC is responsive to personally highly meaningful artworks (Vessel et al., 2012, 2013) and an increase of oxygenated haemoglobin in medial and lateral parts of the PFC has been observed when thinking about the creator of an artwork and his intentions (Kreplin & Fairclough, 2015). Apart from the potential appreciation of beauty, access to the artist's intentions has a crucial impact on the art experience (Jucker et al., 2014). Being exposed to absurd art, for example, increases the general need to find meaningful unambiguous structures in the world (Proulx et al., 2011).

The involvement of the TPJ in understanding other minds, such as their goals, beliefs or intentions, is well established (Overwalle, 2009; Schnell et al., 2011; Shamay-Tsoory, 2011) Activation of the TPJ has been shown to be selectively engaged during the aesthetic contemplation of everyday objects placed in unusual contexts (Kirk, 2008) and the recognition of familiar representational artworks that convey a meaning (Fairhall & Ishai, 2008). Kawabata and Zeki (2004) reported a positive relationship between the left TPJ and judgments of beauty, however, we did not find a parametric effect of liking in this region. The same holds for the amygdala. Although the (right) amygdala has been observed to become activated when canonical sculptures were judged as beautiful (DiDo et al., 2007), we do not attribute the involvement of this region during the task-free viewing of paintings to the processing of hedonic pleasure, as we did not observe the amygdala to be predictive for the obtained liking judgments. We rather interpret the activation of this region to reflect the empathic engagement with the social constellations (Tavares et al., 2007) and expressed emotions depicted in the artworks in order to understand them (Morelli & Lieberman, 2013).

The results of the PPI analysis further support our interpretation of a participatory construction of meaning on the part of the beholder that unfolds in particular when no explicit evaluation is required. It seems unlikely that the activation pattern, which partly overlaps with DMN regions (vmPFC, PCC, TPJ), merely reflects unattended, stimulus independent thoughts due to the absence of a concrete task during the presentation of paintings. The stronger an individual's tendency to get involved with characters of novels and films the stronger was the observed functional connectivity between the seed region in the vmPFC and the ACC, IFG, amygdala and PCC/Precuneus. Strikingly, the attribution of personal meaning in response to complex composite artworks has been observed to be positively associated with the disposition to become absorbed in art, literature or film (Cupchik & Gignac, 2007).

Although the fantasy scale provides primarily a measurement of cognitive empathy, the involvement of the amygdala and the IFG suggests that both cognitive and affective aspects of empathy modulate the functional coupling of the vmPFC. These findings complement those of a recent eye movement study on the visual exploration of fine art paintings (Villani et al., 2015), showing that both subcomponents of empathic abilities (here expressed in empathic concern and perspective taking) enhanced the orientation towards faces and body parts of depicted human figures. A large part of the paintings used for this study depicted social agents. It remains an open question to which extend the activation pattern we found reflects the appreciation of the visible scene in a narrow sense or further thoughts about the intentions of the artist in a broader sense. We hypothesize the latter to be the case. In support of this assumption, an exploratory post-hoc analysis testing for a parametric effect of social cues (varying in four steps from still lifes to clearly recognizable faces) revealed no modulation of the mentalizing network during free viewing. This suggests that the social content of the artworks alone cannot explain the engagement of the mentalizing network. Correspondingly, a selective engagement of the vmPFC has been observed for images that have been declared belonging to a gallery as opposed to be generated by a computer (Kirk et al., 2009). Likewise, a recipients assumption that a work of music was composed by a human being as opposed to a computer suffices the engagement in ToM (Steinbeis & Koelsch, 2009). Elsewhere it has been argued that the artists' intention to convey a meaning is central to the aesthetic experience (Bundgaard, 2015), whereas the recipient, on the other hand, expects an intentional communicative act. According to that view, the artists' competence in the selection of materials, color, forms and composition attracts the attention of the beholder thus providing a framework for interpretation (Carrol et al., 2012).

The differences in brain activity between the *explicit judgment* and the *free viewing* condition are in accordance with a previous imaging study investigating the effect of cognitive load on empathy with individuals on photographs (Morelli & Liebermann, 2013). Whereas task-free viewing engaged the same brain responses as for active empathizing, cognitive load resulted in diminished activation of brain regions that are associated with empathy and social cognition (including vmPFC, TPJ, PCC, pSTS, temporal poles and amygdala), but elicited an increase in the frontoparietal control network (dACC, AI, ventrolateral PFC, DLPFC). Accordingly, our results show a task-dependent modulation of brain responses, such that the absence of explicit aesthetic judgment requirements leads to a shift in the neural processing of paintings from judgment-oriented decision making to meaning-making.

Table 4.1 - part 1.

Brain activations during the perception of paintings that predict the subsequent liking judgments assessed either inside (explicit judgment) or outside the scanner (free viewing).

Brain regions	Laterality	BA	Coordinates			k	t
			x	y	z		
Frontal lobe							
	R	11	27	35	-20	26	4,36
OFC	R	11	36	35	-20	13	5,18
	L	11	-33	35	-20	56	5,08
IFG	L	46	-48	44	13	72	5,11
Subcallosal Gyrus	L	47	-18	20	-11	22	4,08
Superior Frontal Gyrus	L	6	-21	17	64	23	4,47
	L	6	-21	11	52	22	3,84
	L	6	0	5	61	18	3,71
Precentral Gyrus	R	6	42	-1	31	10	3,85
Temporal lobe							
Posterior Middle Temporal Gyrus	L	39	-42	-76	22	21	4,09
Inferior Temporal Gyrus	R	37	57	-58	-5	16	3,83
	L	20	-51	-49	-8	27	4,47
Hippocampus	R		30	-31	-8	54	4,83
Limbic lobe							
PCC	R	30	21	-55	16	166	5,13
Parahippocampal Gyrus	L	30	-15	-34	-5	89	4,66
	L	28	-18	-22	-8	40	4,31
Uncus	L	28	-21	5	-29	48	6,26
Midcingulate Cortex	R	24	3	-1	31	12	4,39
Midbrain							
Red Nucleus	L		0	-16	-5	80	5,28
Parietal Lobe							
Superior Parietal Lobule	R	7	27	-58	46	74	4,8
	L	7	-30	-52	43	12	3,86
Precuneus	R	7	15	-82	46	62	4,66
	L	7	-15	-76	52	233	4,57
	L	7	-15	-76	52	48	4,57
	L	7	-15	-70	43	19	3,76
	L	19	-15	-85	43	42	3,97

Table 4.1 - continued.

Occipital Lobe							
Lingual Gyrus	R	19	15	-46	-2	213	5,96
	L	18	-6	-61	4	314	6,23
	L	19	-15	-49	-2	161	5,74
Middle Occipital Gyrus	R	19	33	-82	10	35	3,91
	R	19	36	-85	19	25	3,55
Superior Occipital Gyrus	L	19	-30	-79	25	103	4,28
Precuneus	R	31	27	-70	22	98	4,42
Subcortical							
Dorsal Striatum	R		18	-4	13	11	3,68
	R		6	11	7	120	5,02
	L		-9	8	4	121	4,89
Ventral Striatum	L		-18	8	-8	44	5,07
Thalamus	R		6	-28	1	109	5,65
	R		3	-7	13	135	5,39
	R		18	-16	-2	12	3,7
	L		-3	-28	4	80	5,35
	L		-6	-19	7	66	4,84
	L		-15	-19	13	38	4,46
	L		-21	-25	1	15	4,27
	L		-24	26	-2	13	4,02
Cerebellum							
Anterior Lobe	R		15	-34	-8	91	6,38
	L		-3	-49	-26	147	5,35
	L		-3	-49	-26	103	5,35
Posterior Lobe	R		18	-37	-35	45	5,17
	R		18	-37	-35	36	5,17
	R		9	-73	-20	10	3,71
	L		-24	-58	-14	42	3,97
	L		-12	-40	-35	35	4,67

Note. Brodmann area, Talairach coordinates and t-score for the peak voxel of significantly activated regions; whole-brain corrected ($p < 0.05$) using FDR. OFC, orbito-frontal cortex; IFG, inferior frontal gyrus; STG, superior temporal gyrus; PCC, posterior cingulate cortex.

Table 4.2. Brain activations during the perception of paintings that predict the subsequent liking judgments contrasting the free viewing with explicit judgment.

Brain regions	Laterality	BA	Coordinates			k	t
			x	y	z		
free viewing > explicit judgment							
Frontal lobe							
OFC	R	11	36	56	-17	24	4,24
Temporal lobe							
Fusiform Gyrus	R	37	42	-37	-14	18	4,46
Limbic lobe							
Parahippocampal Gyrus	R	28	21	-28	-14	5	3,83
Parahippocampal Gyrus	L	19	-39	-43	-8	8	3,96
Occipital lobe							
LOC	R	37	48	-67	1	4	3,57
explicit judgment > free viewing							
Frontal lobe							
OFC	R	11	24	38	-14	15	-5,42
Superior Frontal Gyrus	R	8	24	41	43	38	-4,53
Middle Frontal Gyrus	L	8	-30	38	40	8	-4,05
Middle Frontal Gyrus	R	9	39	50	31	26	-5,03
Superior Frontal Gyrus	R	10	21	62	13	5	-3,99
Superior Frontal Gyrus	R	10	27	53	-2	4	-3,85
Limbic lobe							
ACC	L	32	-6	38	13	4	-3,83
Uncus	R	28	15	-7	-26	8	-4,29
Subcortical							
Insula	R	13	30	14	16	6	-3,95

Note. Brodmann area, Talairach coordinates and t-score for the peak voxel of significantly activated regions; whole brain corrected ($p < 0.05$) using FDR. OFC, orbito-frontal cortex; LOC, lateral occipital cortex; ACC, anterior cingulate cortex; PCC.

Table 4.3. Brain responses during the explicit judgment condition > free viewing of paintings.

Brain regions	Laterality	BA	Coordinates			k	t
			x	y	z		
Frontal Lobe							
OFC	R	11	27	56	-17	66	4,7
	R	11	33	44	-20	38	3,95
	R	11	24	44	-23	20	3,64
	R	11	21	38	-8	26	4,54
	L	11	-33	38	-23	26	4,55
	L	11	-21	44	-5	17	3,43
	L	11	-24	50	-20	82	4,57
dlPFC	R	46	45	29	22	311	8,56
	R	10	27	62	-5	46	3,64
	L	10/46	-42	41	19	172	4,76
IFG/vlPFC	R	44	45	17	13	181	7,12
	R	10/46	36	44	-2	192	6,31
IFG/Anterior Insula	L	47/13	-30	20	-2	150	5,83
Medial Frontal Gyrus	R	8	3	20	46	591	8,73
	R	6	9	26	34	233	7,26
	R	6	30	2	55	189	4,83
	R	8	48	29	40	225	6,06
	R	9/10	42	47	25	209	5,45
	L	9	-42	26	34	155	4,81
Precentral Gyrus	R	6	45	2	31	242	5,94
	L	6	-45	-1	34	71	5,02
Sub-Gyral	L	6	-15	-4	52	191	6,44
Superior Frontal Gyrus	R	10	24	47	-2	79	5,03
	L	6	-15	2	67	15	3,13
Temporal Lobe							
Fusiform Gyrus	R	37	33	-49	-11	325	6,41
	L	37	-45	-49	-14	92	4,47
	L	37	-48	-40	-14	22	4,46
Limbic Lobe							
dACC	L	32	-9	26	31	224	6,32
PCC	L	23	-3	-16	28	20	3,23
	R	30	18	-52	16	40	3,59
	L	23	-3	-28	25	28	3,78
Midbrain							
Subthalamic Nucleus	R		6	-13	-5	120	5,76
Subthalamic Nucleus	L		-9	-13	-5	74	5,51

Table 4.3 - continiued

Parietal Lobe							
Inferior Parietal Lobule	R	40	48	-46	55	88	3,6
Precuneus	R	7	21	-64	40	527	5,78
Precuneus	L	7	-24	-61	37	206	5,85
Precuneus	L	7	-15	-67	43	266	5,29
Sub-Gyral	L	40	-33	-43	34	105	4,4
Superior Parietal Lobule	R	7	33	-76	49	40	4,17
	L	7	-12	-73	58	51	3,94
	L	7	-21	-73	58	41	3,94
Supramarginal Gyrus	L	40	-42	-40	37	53	3,9
Occipital Lobe							
Fusiform Gyrus	L	19	-24	-64	-5	260	7,76
Inferior Occipital Gyrus	R	19	45	-70	-8	51	3,43
	L	18	-33	-82	-2	233	5,25
	L	18	-48	-76	-2	144	5,87
Lingual Gyrus	R	18	27	-70	-8	180	5,55
Lingual Gyrus	R		18	-76	1	67	3,28
Middle Occipital Gyrus	R	18	27	-88	4	187	4,42
	R	18	33	-94	13	117	4,03
	R	19	39	-79	4	71	3,47
	L	18	-30	-91	13	203	5,75
Precuneus	L	31	-27	-70	19	97	4,04
Subcortical							
Dorsal Striatum	R		15	11	13	78	4,14
	L		-15	5	10	164	5,28
Anterior Insula	R	13	36	20	4	281	7,17
Anterior Insula/Claustrum	L	13	-27	20	10	199	7,46
Thalamus	R		9	-7	4	194	5,81
	R		3	-28	1	52	3,8
	L		-12	-13	10	159	5,01
	L		-12	-22	-2	77	4,43
Cerebellum							
Anterior Lobe	R		0	-49	-26	102	6,86
	R		30	-55	-23	210	5,51
	L		-30	-55	-26	334	6,52
	L		-45	-40	-26	49	4,29
	L		-15	-37	-29	48	4,08
	L		-30	-37	-29	46	3,73
	L		-6	-28	-26	31	3,35
Posterior Lobe	R		24	-61	-11	120	5,37
	R		9	-73	-20	97	4,94
	R		45	-79	-32	10	4,14
	L		-24	-73	-11	213	6,65
	L		-9	-73	-26	98	5,49

Note. Brodmann area, Talairach coordinates and t-score for the peak voxel of significantly activated regions; whole-brain corrected ($p < 0.05$) using FDR. OFC, orbito-frontal cortex; dlPFC, dorsolateral prefrontal cortex; IFG, inferior frontal gyrus; dACC, dorsal anterior cingulate cortex; PCC, posterior cingulate cortex.

Table 4.4. Brain responses during the free viewing of paintings > explicit judgement

Brain regions	Laterality	BA	Coordinates			k	t
			x	y	z		
Frontal Lobe							
vmPFC	L	10	0	56	1	86	4,1
Medial Frontal Gyrus	R	6	6	-13	58	25	3,44
	L	6	-6	-19	64	28	3,65
Paracentral Lobule	R	6	9	-28	67	85	4,05
Precentral Gyrus	R	6	57	-1	7	193	5,67
	L	6	-57	-1	13	96	5,88
	L	6	-63	2	22	15	4,02
Dorsal PCC	R	31	9	-28	46	58	4,21
Temporal Lobe							
Angular Gyrus	R	39	48	-70	31	23	3,48
	L	39	-42	-73	31	47	4,06
Middle Temporal Gyrus	R	21	69	-46	1	85	5,49
	R	21	60	-1	-5	94	5,48
	L	21	-54	-43	7	259	6,13
	L	21	-57	-19	-2	200	5,77
Superior Temporal Gyrus	R	21	60	-10	-2	205	6,43
	R	22	60	-37	10	185	5,67
	R	41	51	-28	10	141	5,21
	L	22	-63	-4	4	133	6,18
	L	22	-45	-4	-5	144	5,36
pSTS/TPJ	R	22	63	-46	16	145	4,22
	L	39	-48	-58	19	61	4,03
Supramarginal Gyrus/TPJ	L	40	-51	-49	19	92	4,28
Temporal Pole	R	38	54	14	-20	68	4,07
	R	38	48	14	-32	12	3,24
	L	38	-48	14	-23	20	3,85
Transverse Temporal Gyrus	L	42	-57	-16	10	76	4,2
Limbic Lobe							
Amygdala	R		27	-10	-11	11	3,28
	L		-24	-4	-14	12	3,41
Dorsal PCC	R	31	24	-31	43	99	5,51

Table 4.4 - continiued.

Parietal Lobe							
Inferior Parietal Lobule	L	40	-45	-28	25	50	4,13
Precuneus	L	7	-15	-46	58	20	3,7
Precuneus/PCC	L	31	-12	-46	31	18	3,39
Supramarginal Gyrus	L	40	-63	-52	37	11	3,08
Postcentral Gyrus	R	40	60	-22	16	206	5,07
	R	2	69	-19	31	104	4,6
	R	3	45	-25	64	56	4,47
	R	3	51	-13	55	57	4,39
	R	3	39	-19	49	102	3,94
	R	5	24	-46	70	58	3,6
	L	40	-66	-19	13	66	4,47
	L	40	-60	-22	22	50	3,67
	L	3	-48	-19	52	54	3,83
	L	5	-27	-43	64	11	2,96
Subcortical							
Posterior Insula	R	13	39	-16	10	111	4,14

Note. Brodmann area, Talairach coordinates and t-score for the peak voxel of significantly activated regions; whole-brain corrected ($p < 0.05$) using FDR. PCC, posterior cingulate cortex; vmPFC, ventromedial prefrontal cortex; pSTS, posterior temporal sulcus; TPJ, temporoparietal junction.

Table 4.5.
Results of the PPI analysis - areas of the brain that showed higher functional connectivity with vmPFC during the free viewing of artworks, depending on self-report scores at the fantasy scale.

	Brain regions	Laterality	BA	Coordinates			k	r^2
				x	y	z		
Frontal lobe								
	Superior Frontal Gyrus	R	10	21	47	16	50	0,69
		L	10	-15	50	16	15	0,65
	IFG	R	47	21	35	-2	127	0,72
		R	47	21	35	-2	37	0,72
	Medial Frontal Gyrus	R	10	15	47	7	40	0,68
		R	10	36	38	13	11	0,65
	Precentral Gyrus	L	6	-63	-4	25	35	0,70
		R	6	48	-7	7	10	0,68
	Middle Frontal Gyrus	R	6	24	-13	46	7	0,66
	Precentral Gyrus	R	6	27	-10	61	9	0,66
Limbic lobe								
	ACC	L	32	-6	35	16	71	0,78
		L	32	-6	35	16	46	0,78
		R	24	9	32	13	10	0,65
	Amygdala	L		-24	-4	-29	17	0,66
	PCC	R	30	9	-64	13	5	0,61
Parietal Lobe								
	Precuneus	R	7	18	-43	49	19	0,67
Occipital Lobe								
	Middle Occipital Gyrus	R	37	45	-67	1	33	0,68
	Cuneus	L	18	0	-76	19	16	0,63
Subcortical								
	Insula	R	13	36	-22	-2	17	0,68
	Lentiform Nucleus	R		18	-4	13	8	0,66
	Cuneus	R	19	6	-94	31	22	0,64
		L	18	0	-91	7	21	0,63
	Uvula	L		-6	-94	-38	5	0,63

Note. Brodmann area, Talairach coordinates and t-score for the peak voxel of significantly activated regions; corrected for multiple comparisons at cluster level $p < .05$ with an initial voxel level threshold of $p < .001$, uncorrected; IFG, inferior frontal cortex; ACC, anterior cingulate cortex; PCC, posterior cingulate cortex.

5. General Discussion and Outlook

This dissertation project aimed at testing four main hypotheses:
(1) the *fiction-feeling hypothesis* stating that literary texts invite readers to engage empathically with the protagonists and immerse in the text world.
(2) the *Panksepp-Jakobson hypothesis* stating that the neural networks underlying the processing of reading reuse the ancient emotion circuits that become engaged in every day emotional processing.
(3) the *simulation hypothesis* and (4) the *modulation by context hypothesis,* according to which, e.g., genre expectations (reading a fictional crime story vs. reading a fact-based newspaper article) shape the neural processing of the text material.

The results of study 1 (reported in Chapter2) support the *Panksepp-Jakobson hypothesis:* Reading text material with a narrative structure engages the same ancient emotion circuits as for the processing of non-fictional, evidence based 'real world' phenomena (e.g., the mentalizing network). The data of study 1 and study 2 (reported in Chapter 2 and 3) also support the *fiction-feeling hypothesis:* An empathic engagement with the story content was observed, when participants read negatively valenced (fictional) stories. The results of Study 2 additionally support the *simulation hypothesis* proposed by Mar & Oatley (2008), in conjunction with the *modulation-by-context hypothesis* derived from the NCPM (Jacobs, 2011; 2015a, b), as the data suggest a constructive simulation of what might have happened when the events depicted in a text are believed to be fictitious. The *extended modulation-by-context hypothesis* tested in the domain of representational art (study 3) revealed the manifestation of a specific processing mode, depending on task (explicit judgment vs. free contemplation).

The main finding throughout all the studies of this dissertation project, however, concerns the importance of empathy on reading and art perception:
(1a) Reading of unpleasant stories activated the affective mentalizing network (cognitive empathy; including the bilateral mPFC, the supramarginal gyrus/TPJ, and

the left DLPFC). (1b) Reading of unpleasant, but simultaneously liked, stories engaged the mPFC. This region showed a functional coupling with brain regions known to be involved in ToM and affective empathy. (1c) An additional PPI analysis taking into account the self reported tendency to feel concern for other people informed this finding: the higher the empathic concern score, the stronger was the observed coactivation of the bilateral anterior insula (AI, BA 13) and the right posterior cingulate cortex (PCC, BA 31).

(2a) Reading of stories labeled as 'fiction' engaged the frontoparietal control network (including FPC, DLPFC, dACC) and default mode network regions (IPL, PCC). (2b) A PPI analysis taking into account the self reported tendency to engage with characters of novels and film informed this finding: the higher the fantasy score, the stronger was the observed coactivation of the rFPC and the mPFC.

(3a) The task-free contemplation of artworks engaged the affective mentalizing network. (3b) A PPI analysis taking into account the self reported tendency to engage with characters of novels and film supported this finding: the higher the fantasy score, the stronger was the observed coactivation of the vmPFC and empathy related regions of the brain (ACC, IFG, Amygdala and PCC/Precuneus).

Recent empirical findings highlight the important role of empathy for the process of reading (Hsu, Conrad, & Jacobs, 2014; Kidd & Castano, 2013; Koopman, 2015; 2016; for an overview see Oatley, 2016). It has been shown, for instance, that dyslexic study participants with impaired reading abilities exhibit lower scores on empathy scales compared to unimpaired readers (Gabay, Shamay-Tsoory, & Goldfarb, 2016). Henschel & Roik, (2013) reported a positive relationship between fantasy-empathy and text comprehension. Morelli & Liebermann (2013) demonstrated that empathic processes to become effective presuppose diminished cognitive load. The results of the data, that constitute this dissertation, as well as those obtained from other research projects suggest that self paced literary reading and contemplation of artworks provide optimal grounds for empathy to take full effect.

The studies upon which this dissertation has focused (reported on in Chapters 2-4) revealed immersion-enhancing empathic responses upon exposure to representational paintings and texts with a narrative structure, the latter depending on contextual factors such as genre expectations, which can facilitate the simulation of possible events. Hence, the data support the hypotheses derived from the upper route of the NCPM (*Jacobs,* 2011; 2015a, b), namely the *Panksepp-Jakobson hypothesis,* the *fiction-feeling hypothesis,* the *modulation by context hypothesis*, as well as the *simulation hypothesis* proposed by Mar & Oatley (2008, see also Oatley 1995, 1999).

Interestingly, the data also provide evidence for a connection with the lower route of the NCPM: the reader will recall that the reading of unpleasant stories, that were simultaneously liked, engaged the mPFC. This region is part of the ToM network, and shows a functional coupling with other brain regions known to be involved in ToM and affective empathy. Moreover, the functional coupling of the mPFC and empathy-related brain regions was found to be stronger, the higher the individual empathic concern score of the subject participating in the study. In other words, the interplay of fiction feelings (induced by the negative valence of the stories) and aesthetic emotions (here, the liking of the stories) influences the ToM level of engagement.

Thus, one of the most inspiring questions for future research projects pertains to the relationship between the background-driven route and the foreground-driven route explicated in the NCPM: that is to say, to what extent might ToM valence, immersion, aesthetic emotions, and elements of (aesthetic) foregrounding, interact. Jacobs' NCPM model (Fig. 1.1) in its actual form hypothesizes a, "duality of immersive and aesthetic processes being conceived as rival forces driven by different text features and their implicit vs. explicit processing" (Jacobs & Lüdtke, 2017, p. 1). Recent data challenge this assumption. Jacobs, Lüdtke, & Meyer-Sickendiek (2013) conducted a study aimed at investigating the mood induction effects of highly structured poetic material. The authors enquired how abstract (i.e. foregrounding) poetry can be without affecting mood empathy. Jacobs, Lüdtke, & Meyer-Sickendiek (2013) concluded that empathic responses, invoked by poetic backgrounding, influence foreground-driven aesthetic responses, thus mitigating against an antagonistic relationship between background and foreground. Similar results are reported by

Castiglione (2017): poems that were difficult but provided a basic narrative schema were read more fluently, compared to poems missing a narrative structure. Castiglione (2017) in this regard presented an overview of linguistic determinants of text difficulty, and differentiated slowed, 'compromised reading' caused by text difficulty (such as word meaning) from slowed reading as 'time investment' in, for example, aesthetic processing driven by the elusive meaning of poetic language. The author asked a different sample of readers whether or not they enjoyed the poems and found, "a strong tendency for poems assessed as difficult to be enjoyed the least" (Castiglione, 2017, p. 26).

From this perspective, elements of foregrounding have the potential to both facilitate and compromise the processing and meaning-construction of artistic language. As these data were obtained in reference only to poetry, and considering the focus on poetic language of the NCPM in its actual form, the reported evidence does not appear sufficient to justify a modification of the NCPM. However, it does appear that it is worth considering a possible interaction of foregrounding and backgrounding. A literary excerpt taken from 'The Sorrows of Young Werther' by Johann Wolfgang von Goethe exemplifies this line of thought:

Am 10. Mai

Eine wunderbare Heiterkeit hat meine ganze Seele eingenommen, gleich den süßen Frühlingsmorgen, die ich mit ganzem Herzen genieße. Ich bin allein und freue mich meines Lebens in dieser Gegend, die für solche Seelen geschaffen ist wie die meine. Ich bin so glücklich, mein Bester, so ganz in dem Gefühle von ruhigem Dasein versunken, daß meine Kunst darunter leidet. Ich könnte jetzt nicht zeichnen, nicht einen Strich, und bin nie ein größerer Maler gewesen als in diesen Augenblicken. Wenn das liebe Tal um mich dampft, und die hohe Sonne an der Oberfläche der undurchdringlichen Finsternis meines Waldes ruht, und nur einzelne Strahlen sich in das innere Heiligtum stehlen, ich dann im hohen Grase am fallenden Bache liege, und näher an der Erde tausend mannigfaltige Gräschen mir merkwürdig werden; wenn ich das Wimmeln der kleinen Welt zwischen Halmen, die unzähligen, unergründlichen Gestalten der Würmchen, der Mückchen näher an meinem Herzen fühle, und fühle die Gegenwart des Allmächtigen, der uns nach seinem Bilde schuf, das Wehen des Alliebenden, der uns in ewiger Wonne schwebend trägt und erhält; mein Freund! Wenn's dann um meine Augen dämmert, und die Welt um mich her und der Himmel ganz in meiner Seele ruhn wie die Gestalt einer Geliebten – dann sehne ich mich oft und denke : ach könntest du das wieder ausdrücken, könntest du dem Papiere das einhauchen, was so voll, so warm in dir lebt, daß es würde der Spiegel deiner Seele, wie deine Seele ist der Spiegel des unendlichen Gottes! – mein Freund – aber ich gehe darüber zugrunde, ich erliege unter der Gewalt der Herrlichkeit dieser Erscheinungen. [...] (http://gutenberg.spiegel.de/buch/die-leiden-des-jungen-werther-3636/1)[1]

In this letter to his friend Wilhelm, the young Werther describes his deeply felt pantheism. Several textual elements emphasize Werther's impressions. His experience of merging with nature, for instance, is emphasized by use of one long sentence, starting from line 7. Several commas and semicolons string together the protagonist’s flood of perceptions of the divine in the smallest of plants and insects, and the anaphoric use of the word *wenn* (english: *when*; lines 7, 11, 14) additionally interconnects otherwise separate sentences. In effect, the foregrounding devices seem to accelerate the reading speed, and to enhance the reader’s empathic responses towards Werther. Although much more could be said about this text excerpt, it illustrates the potentially reciprocal reinforcement of backgrounding and foregrounding elements. It might be that an individual scope could be determined for each reader, in which both processing modes positively reinforce each other.

Such positive reinforcement of foreground and background might not come into effect immediately on commencing the reading process, but later on, when the reader is familiarised with the work of the author. Many readers know the phenomenon: when, for instance, reading Goethe's 'The Sorrows of Young Werther' for the first time, the reading process is initially decelerated, as the recipient is confronted with two

[1] MAY 10.
A wonderful serenity has taken possession of my entire soul, like these sweet mornings of spring which I enjoy with my whole heart. I am alone, and feel the charm of existence in this spot, which was created for the bliss of souls like mine. I am so happy, my dear friend, so absorbed in the exquisite sense of mere tranquil existence, that I neglect my talents. I should be incapable of drawing a single stroke at the present moment; and yet I feel that I never was a greater artist than now. When, while the lovely valley teems with vapour around me, and the meridian sun strikes the upper surface of the impenetrable foliage of my trees, and but a few stray gleams steal into the inner sanctuary, I throw myself down among the tall grass by the trickling stream; and, as I lie close to the earth, a thousand unknown plants are noticed by me: when I hear the buzz of the little world among the stalks, and grow familiar with the countless indescribable forms of the insects and flies, then I feel the presence of the Almighty, who formed us in his own image, and the breath of that universal love which bears and sustains us, as it floats around us in an eternity of bliss; and then, my friend, when darkness overspreads my eyes, and heaven and earth seem to dwell in my soul and absorb its power, like the form of a beloved mistress, then I often think with longing, Oh, would I could describe these conceptions, could impress upon paper all that is living so full and warm within me, that it might be the mirror of my soul, as my soul is the mirror of the infinite God! O my friend—but it is too much for my strength—I sink under the weight of the splendour of these visions! [...]http://www.gutenberg.org/files/2527/2527-h/2527-h.htm

tasks, reflected in the upper and lower routes of the NCPM (*Jacobs,* 2011; 2015a, b): (1) The constellation of the protagonists and the starting point of the storyline/plot has to be grasped (situation model construction). (2) In parallel, the reader conceives the writing style of the author, including elements of foregrounding, which also brings the lower route of the NCPM heavily into use. Readers are likely to adopt their reading speed to the perceived writing style and their ability to extract meanings, given the polyvalence of the specific text. If the book is not put down on account of difficulty accomplishing one or both of the 'comprehension tasks' in a satisfying manner, readers regularly report that the reading process becomes more fluent, and that they get immersed into the narrative world. Hence, considering the time course of the reading process, extending long-term effects might be a promising approach for the empirical study of literature (for long-term effects, see, for example, Bal & Veltkamp, 2013, who reported that high transportation in a fictional narrative led to higher empathy scores one week after reading the narrative).

Several recent empirical findings suggest an interplay of background elements facilitating immersion and ToM on the one hand, and foreground elements facilitating the aesthetic trajectory on the other. Most recently, it has been argued, for instance, that foregrounding can enrich and intensify meaningful engagement with absorbing narratives (Bálint, Hakemulder, Kuijpers, Doicaru, & Tan, 2017). Kidd & Castano (2013) presented short-term effects of reading literary fiction. When compared to popular fiction, or nothing at all, literary fiction generated higher scores on scales measuring cognitive and affective ToM in readers. Similarly, Pino & Mazza (2016) observed an improvement in mentalizing abilities after the reading of literary fiction, compared to science fiction or nonfiction. Koopman (2016) directly manipulated foregrounding elements in a literary text, and found post-reading empathy scores to be lower for the manipulated text version, which contained remarkable foregrounding, and higher for the original text version rich in foregrounding. In accordance with these findings, a study conducted by Citron, Güsten, Michaelis, & Goldberg (2016) revealed increasing metaphoricity in longer text passages to be predictive of amygdala activity; complexity, however, did not correlate with amygdala activation. The results thus fit the above-mentioned differentiation proposed by Castiglione (2017,) between compromised reading caused by text difficulty and aesthetic processing driven by the elusive meaning of poetic language.

Taken together, it can be claimed that deviation or defamiliarization can, but does not necessarily, inhibit immersive processes, which might depend on the difficulty perceived by the individual reader. From this perspective, readers can become immersed in a novel such as Jane Austen’s "Pride and Prejudice" and, at the same time, experience foregrounding elements without departing from this state of immersion. When, for instance, the dialogue between protagonists within a narrative world comprise elements of foregrounding, the decoding of these elements by the reader might critically contribute to the immersive power of the narration. Reading flow and enjoyment in "Pride and Prejudice" are, crucially, shaped through irony of the protagonists as a rhetorical device. Please refer to Appendix 2 for an exemplary excerpt of the novel in reflection of this.

The findings related to the perception of representational art (see Chapter 4) also prompt consideration of a parallel processing of form and content; the appreciation of paintings remains unattached to the task of focusing on the judgment of beauty, or to free contemplation, which invites the beholder to engage empathically. A good summary of this outlook section is provided by Ryan's (2001) elaboration of the topic: "Nowadays we take the lifelikeness of the cinematic image largely for granted, but when we contemplate a photorealistic artwork, such as a painting by Andrew Wyeth, the sharpness of the image is as present to the mind as the depicted scene. If this view also holds for the literary experience, we can at the same time, or without radical change in perspective, enjoy the imaginative presence of a fictional world and admire the virtuosity of the stylistic performance that produces the sense of its presence." (Ryan, 2001, p. 351).

References

Abraham, A., Cramon, D. Y. von, & Schubotz, R. I. (2008a). Meeting George Bush versus Meeting Cinderella: The Neural Response When Telling Apart What is Real from What is Fictional in the Context of Our Reality. *Journal of Cognitive Neuroscience*, *20*(6), 965-976. doi: 10.1162/jocn.2008.20059.

Abraham, A., Schubotz, R. I., & Cramon, D. Y. von. (2008b). Thinking about the future versus the past in personal and non-personal contexts. *Brain Research*, *1233*, 106-119. doi: 10.1016/j.brainres.2008.07.084.

Abu-Akel, A., & Shamay-Tsoory, S. (2011). Neuropsychologia neuroanatomical and neurochemical bases of theory of mind. *Neuropsychologia* 49, 2971–2984.

Addis, D. R., Pan, L., Vu, M.-A., Laiser, N., & Schacter, D. L. (2009). Constructive episodic simulation of the future and the past: distinct subsystems of a core brain network mediate imagining and remembering. *Neuropsychologia*, *47*(11), 2222-2238. doi: 10.1016/j.neuropsychologia.2008.10.026.

Amodio, D. M., & Frith, C. D. (2006). Meeting of minds: the medial frontal cortex and social cognition. *Nature Reviews Neuroscience*, *7*(4), 268-277. doi: 10.1038/nrn1884.

Appel, M., & Richter, T. (2007). Persuasive effects of fictional narratives increase over time. *Media Psychology*, *10*(1), 113-134.

Arnold, M. B. (1960). Emotion and personality (Vols. 1 & 2), Psychological aspects. New York, NY: Columbia University Press.

Bal, P. M., & Veltkamp, M. (2013). How does fiction reading influence empathy? An experimental investigation on the role of emotional transportation. *PloS one*, *8*(1), e55341.

Bálint, K., Hakemulder, F., Kuijpers, M., Doicaru, M., & Tan, E. S. (2017). Reconceptualizing foregrounding. *Scientific Study of Literature*, *6*(2), 176-207.

Ball, P. (2013). Neuroaesthetics is killing your soul. *Nature.* doi:10.1038/nature.2013.12640

Baumeister, R. F., Zhang, L., & Vohs, K. D. (2004). Gossip as cultural learning. *Rev. Gen. Psychol.* 8, 111–121.

Baumgarten, A. G. (1961/1750). *Ästhetik*, Felix Meiner Verlag, Hamburg, 2007.

Baumgartner, T., Speck, D., Wettstein, D., Masnari, O., Beeli, G., & Jäncke, L. (2008). Feeling present in arousing virtual reality worlds: prefrontal brain regions differentially orchestrate presence experience in adults and children. *Frontiers in Human Neuroscience*, *2*, doi: 10.3389/neuro.09.008.2008.

Berthoz, S., Armony, J. L., Blair, R. J. R., & Dolan, R. J. (2002). An fMRI study of intentional and unintentional (embarrassing) violations of social norms. *Brain* 125, 1696–1708.

Bohrn, I. C., Altmann, U., Lubrich, O., Menninghaus, W., & Jacobs, A. M. (2012): Old proverbs in new skins—An fMRI study on defamiliarization. *Frontiers in Psychology, 3,* 204. doi:10.3389/fpsyg.2012.00204

Bohrn, I. C., Altmann, U., Lubrich, O., Menninghaus, W., & Jacobs, A. M. (2013). When we like what we know–A parametric fMRI analysis of beauty and familiarity. *Brain and Language, 124*(1), 1–8. doi:10.1016/ j.bandl.2012.10.003

Bonelli, S. B., Powell, R. H. W., Yogarajah, M., Samson, R. S., Symms, M. R., Thompson, P. J., et al. (2010). Imaging memory in temporal lobe epilepsy: predicting the effects of temporal lobe resection. *Brain*, *133*, 1186-1199. doi: 10.1093/brain/awq006.

Brieber, D., Nadal, M., Leder, H., & Rosenberg, R. (2014). Art in time and space: Context modulates the relation between art experience and viewing time.

Brink, T., Urton, K., Held, D., Kirilina, E., Hofmann, M., Klann-Delius, G., Jacobs, A. M., & Kuchinke, L. (2011). The role of orbitofrontal cortex in processing empathy stories in 4-8 year-old children. *Front. Psychol.* 2:80. doi: 10.3389/fpsyg.2011.00080

References

Britton, J. C., Phan, K. L., Taylor, S. F., Welsh, R. C., Berridge, K. C., & Liberzon, I. (2006). Neural correlates of social and nonsocial emotions: an fMRI study. *Neuroimage* 31, 397–409.

Bruner, J. (1986). *Actual Minds, Possible Worlds.* Cambridge, MA: Harvard University Press.

Buccino, G., Binkofski, F., Fink, G. R., Fadiga, L., Fogassi, L., Gallese, V., et al. (2001). Action observation activates premotor and parietal areas in a somatotopic manner: an fMRI study. *European Journal of Neuroscience, 13*(2), 400-404. doi: 10.1046/j.1460-9568.2001.01385.x.

Buckner, R. L., Andrews-Hanna, J. R., & Schacter, D. L. (2008). The brain's default network: anatomy, function, and relevance to disease. *Annals of the New York Academy of Sciences*, *1124*, 1–38. doi:10.1196/annals.1440.011

Bundgaard, P. (2014). Feeling, Meaning, and Intentionality: a critique of the neuroaesthetics of beauty. *Phenomenology and the Cognitive Sciences*, 1-21. 10.1007/s11097-014-9351-5

Calvo-Merino, B., Grèzes, J., Glaser, D. E., Passingham, R. E., & Haggard, P. (2006). Report Seeing or Doing ? Influence of Visual and Motor Familiarity in Action Observation. *Current Biology*, *16*, 1905-1910. doi: 10.1016/j.cub.2006.07.065.

Carr, L., Iacoboni, M., Dubeau, M.-C., Mazziotta, J. C., & Lenzi, G. L. (2003). Neural mechanisms of empathy in humans: a relay from neural systems for imitation to limbic areas. *Proc. Natl. Acad. Sci. U.S.A.* 100, 5497–5502.

Carroll, N., Moore, M., & Seeley, W. P. (2012). The Philosophy of Art and Aesthetics, Psychology, and Neuroscience. *Aesthetic science: Connecting minds, brains, and experience*, 31.

Castiglione, D. (2017). Difficult poetry processing: Reading times and the narrativity hypothesis. *Language and Literature*, *26*(2), 99-121.

Cela-Conde, C. J., Marty, G., Maestu, F., Ortiz, T., Munar, E., Fernandez, A., et al. (2004). Activation of the prefrontal cortex in the human visual aesthetic perception. *Proceedings of the National Academy of Sciences*, *101*, 6321–6325.

Cela-Conde, C.J., Agnati, L., Huston, J.P., Mora, F., Nadal, M. (2011). The neural foundations of aesthetic appreciation. *Progress in Neurobiology*, *94*, 39-48. doi:10.1016/j.pneurobio.2011.03.003

Chatterjee, A. (2004). Prospects for a cognitive neuroscience of visual aesthetics. *Bulletin of Psychology and the Arts*, *4*(2), 55–60.

Chatterjee, A. (2011). Neuroaesthetics: a coming of age story. *Journal of cognitive neuroscience*, *23*(1), 53–62. doi:10.1162/jocn.2010.21457

Chatterjee, A., & Vartanian, O. (2014). Neuroaesthetics. *Trends in cognitive sciences*, *18*(7), 370-375.

Chatterjee, A., Thomas, A., Smith, S. E., & Aguirre, G. K. (2009). The neural response to facial attractiveness. *Neuropsychology*, *23*(2), 135–143.

Citron, F. M. M. (2012). Neural correlates of written emotion word processing: a review of recent electrophysiological and hemodynamic neuroimaging studies. *Brain Lang*. Advance online publication. doi: 10.1016/j.bandl.2011.12.007

Citron, F. M., Güsten, J., Michaelis, N., & Goldberg, A. E. (2016). Conventional metaphors in longer passages evoke affective brain response. *NeuroImage*, *139*, 218-230.

Citron, F. M., Güsten, J., Michaelis, N., & Goldberg, A. E. (2016). Conventional metaphors in longer passages evoke affective brain response. *NeuroImage*, *139*, 218-230. Collingwood, R. G. (1938) The principles of art. Oxford University Press.

Conway, M. A., Pleydell-Pearce, C. W., Whitecross, S. E., & Sharpe, H. (2003). Neurophysiological correlates of memory for experienced and imagined events. *Neuropsychologia*, *41*(3), 334-340. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12457758.

Cook, M., & Mineka, S. (1989). Observational conditioning of fear to fear-relevant versus fear-irrelevant stimuli in rhesus monkeys. *Journal of Abnormal Psychology, 98*(4), 448-459.

References

Cooper, E. a, Hasson, U., & Small, S. L. (2011). Interpretation-mediated changes in neural activity during language comprehension. *NeuroImage*, *55*(3), 1314-23. Elsevier Inc. doi:10.1016/j.neuroimage.2011.01.003

Cupchik, G. C., & Gignac, A. (2007). Layering in Art and in Aesthetic Experience. *Visual Arts Research*, *33*(1), 56–71.

Cupchik, G. C., Vartanian, O., Crawley, A., & Mikulis, D. J. (2009). Viewing artworks: contributions of cognitive control and perceptual facilitation to aesthetic experience. *Brain and cognition*, *70*(1), 84-91.

Currie, G. (2011). Empathy for objects. In A. Coplan & P. Goldie (Eds.), *Empathy: Philosophical and psychological perspectives* (pp. 82–97). Oxford, England: Oxford University Press.

Davis, M. H. (1983). Measuring individual differences in empathy: evidence for a multidimensional approach. *Journal of Personality and Social Psychology*, *44*(1), 113–126.

de Wied, M., Zillmann, D., & Ordman, V. (1994). The role of empathic distress in the enjoyment of cinematic tragedy. *Poetics* 23, 91–106.

Decety, J., & Grèzes, J. (2006). The power of simulation: imagining one's own and other's behavior. *Brain Research*, *1079*(1), 4-14. doi: 10.1016/j.brainres.2005.12.115.

Decety, J., & Jackson, P. L. (2004). The functional architecture of human empathy. *Behavioral and cognitive neuroscience reviews, 3*(2), 71-100. doi: 10.1177/1534582304267187.

Di Dio, C., Canessa, N., Cappa, S. F., & Rizzolatti, G. (2011). Specificity of esthetic experience for artworks: an fMRI study. *Frontiers in human Neuroscience*, *5*.

Di Dio, C., Macaluso, E., & Rizzolatti, G. (2007). The golden beauty: brain response to classical and renaissance sculptures. *PloS one*, *2*(11), e1201.

Dijk, T. A. van, & Kintsch, W. (1983). *Strategies of Discourse Comprehension*. New York: Academic Press.

Dinstein, I., Hasson, U., Rubin, N., & Heeger, D. J. (2007). Brain areas selective for both observed and executed movements. *Journal of neurophysiology*, *98*(3), 1415-27. doi: 10.1152/jn.00238.2007.

Djikic, M., & Oatley, K. (2014). The art in fiction: From indirect communication to changes of the self. *Psychology of Aesthetics, Creativity, and the Arts*, *8*(4), 498.

Djikic, M., Oatley, K., Zoeterman, S., & Peterson, J. (2009). On Being Moved by Art: How Reading Fiction Transforms the Self. *Creativity Research Journal*, *21*(1), 24-29. doi: 10.1080/10400410802633392.

Djikic, M., Oatley, K., Zoeterman, S., & Peterson, J. B. (2009a). On being moved by art: How reading fiction transforms the self. *Creativity Research Journal*, *21*(1), 24-29.

Djikic, M., Oatley, K., Zoeterman, S., & Peterson, J. B. (2009b). Defenseless against art? Impact of reading fiction on emotion in avoidantly attached individuals. *Journal of Research in Personality*, *43*(1), 14-17.

Dumontheil, I., Gilbert, S. J., Frith, C. D., & Burgess, P. W. (2010). Recruitment of lateral rostral prefrontal cortex in spontaneous and task-related thoughts. *The Quarterly Journal of Experimental Psychology*, *63*(9), 1740-1756. doi: 10.1080/17470210903538114.

Dunbar, R. I. M. (2004). Gossip in evolutionary perspective. *Rev. Gen. Psychol.* 8, 100–110.

Eco, U. (1994). *Six Walks in the Fictional Woods*. Cambridge: Harvard University Press.

Eippert, F., Veit, R., Weiskopf, N., Erb, M., Birbaumer, N., & Anders, S. (2007). Regulation of emotional responses elicited by threat-related stimuli. *Human brain mapping*, *28*(5), 409-23. doi: 10.1002/hbm.20291.

Elliot, R., Friston, K. J., & Dolan, R. J. (2000). Dissociable neural responses in human reward systems. *The Journal of Neuroscience*, *20*, 6159–6165.

Fabelhafte-buecher.de. (2017a). Die Leserwahl des ZDF: Das große Lesen! | Fabelhafte Bücher. [online] Available at: http://www.fabelhafte-buecher.de/buecher/die-wichtigsten-bucher-der-weltliteratur-aus-westlicher-sicht/die-leserwahl-des-zdf-das-grose-lesen/ [Accessed 30 Jul. 2017].

Fabelhafte-buecher.de. (2017b). Die 100 besten Bücher | Fabelhafte Bücher. [online] Available at: http://www.fabelhafte-buecher.de/buecher/die-wichtigsten-bucher-der-weltliteratur-aus-westlicher-sicht/die-100-besten-bucher-nur-die-liste/ [Accessed 30 Jul. 2017].

Fairhall, S. L., & Ishai, A. (2008). Neural correlates of object indeterminacy in art compositions. *Consciousness and cognition*, *17*(3), 923-932.

Farrer, C., & Frith, C. D. (2002). Experiencing oneself vs another person as being the cause of an action: the neural correlates of the experience of agency. *NeuroImage*, *15*(3), 596-603. doi: 10.1006/nimg.2001.1009.

Farrer, C., Franck, N., Frith, C. D, Decety, J., & Georgieff, N. (2004). Neural correlates of action attribution in schizophrenia. *Psychiatry: Interpersonal and Biological Processes*, *131*, 31-44. doi: 10.1016/j.psychresns.2004.02.004.

Ferstl, E. C., Neumann, J., Bogler, C., & von Cramon, D. Y. (2008). The extended language network: a meta-analysis of neuroimaging studies on text comprehension. *Human brain mapping*, *29*(5), 581-93. doi:10.1002/hbm.20422

Ferstl, E., & von Cramon, D. (2002). What Does the Frontomedian Cortex Contribute to Language Processing: Coherence or Theory of Mind? *NeuroImage*, *17*(3), 1599-1612. doi:10.1006/nimg.2002.1247

Freedberg, D., & Gallese, V. (2007). Motion, emotion and empathy in esthetic experience. *Trends in cognitive sciences*, *11*(5), 197–203. doi:10.1016/j.tics.2007.02.003

Friese, J. (2017). Diese Filme haben uns traumatisiert. Retrieved from https://www.welt.de/vermischtes/article163361307/Diese-Filme-haben-uns-traumatisiert.html

Frijda, N. H. (1986). *The emotions*. Cambridge, England: Cambridge University Press.

Frijda, N. H. (2009). Emotions, individual differences and time course: Reflections. *Cognition and Emotion*, *23*(7), 1444-1461.

Friston, K. J., Buechel, C., Fink, G. R., Morris, J., Rolls, E., & Dolan, R. J. (1997). Psychophysiological and modulatory interactions in neuroimaging. *Neuroimage* 6(3), 218–229.

Frith, C. D., & Frith, U. (2006). The neural basis of mentalizing. *Neuron, 50*(4), 531-534. doi: 10.1016/j.neuron.2006.05.001.

Gabay, Y., Shamay-Tsoory, S. G., & Goldfarb, L. (2016). Cognitive and emotional empathy in typical and impaired readers and its relationship to reading competence. *Journal of clinical and experimental neuropsychology*, *38*(10), 1131-1143.

Galak, J., & Nelson, L. D. (2010). The virtues of opaque prose: How lay beliefs about fluency influence perceptions of quality. *Journal of Experimental Social Psychology*, 8-11. Elsevier Inc. doi: 10.1016/j.jesp.2010.08.002.

Genette, G. (1990). Fictional Narrative, Factual Narrative. *Poetics Today*, *11*(4), 755-774.

Gerlach, K. D., Spreng, R. N., Gilmore, A. W., & Schacter, D. L. (2011). Solving future problems: default network and executive activity associated with goal-directed mental simulations. *NeuroImage*, *55*(4), 1816-24. doi: 10.1016/j.neuroimage.2011.01.030.

German, T. P., Niehaus, J. L., Roarty, M. P., Giesbrecht, B., & Miller, M. B. (2004). Neural correlates of detecting pretense: automatic engagement of the intentional stance under covert conditions. *Journal of Cognitive Neuroscience*, *16*(10), 1805-1817. doi: 10.1162/0898929042947892.

Gerrig, R. J., & Rapp, D.N. (2004). Psychological Processes Underlying Literary Impact. Poetics Today, 25(2), 265-281. doi: 10.1215/03335372-25-2-265.

References

Gilbert, S. J., Spengler, S., Simons, J. S., Frith, C. D., & Burgess, P. W. (2005). Differential Functions of Lateral and Medial Rostral Prefrontal Cortex (Area 10) Revealed by Brain-Behavior Associations. *Cerebral Cortex*, *16*(12), 1783-1789. doi: 10.1093/cercor/bhj113.

Goebel, R., Esposito, F., & Formisano, E. (2006). Analysis of functional image analysis contest (FIAC) data with brainvoyager QX: From single-subject to cortically aligned group general linear model analysis and self-organizing group independent component analysis. *Human brain mapping*, *27*(5), 392-401. doi: 10.1002/hbm.20249.

Goldin, P. R., Hutcherson, C. A. C., Ochsner, K. N., Glover, G. H., Gabrieli, J. D. E., & Gross, J. J. (2005). The neural bases of amusement and sadness: a comparison of block contrast and subject-specific emotion intensity regression approaches. *Neuroimage* 27, 26–36.

Gopnik, B. (2012). *Aesthetic science and artistic knowledge*. In: Aesthetic science: Connecting minds, brains, and experience, ed. A. P. Shimamura & S. E. Palmer, pp. 129–59. Oxford University Press.

Green, M. C. (2004). Transportation Into Narrative Worlds : The Role of Prior Knowledge and Perceived. *Discourse Processes*, *38*(2), 247-266. doi: 10.1207/s15326950dp3802.

Green, M. C., & Brock, T. C. (2000). The role of transportation in the persuasiveness of public narratives. *J. Pers. Soc. Psychol.* 79, 701–721.

Green, M. C., Brock, T. C., & Kaufman, G. F. (2004). Understanding media enjoyment: the role of transportation into narrative worlds. *Commun. Theory* 14, 311–327.

Greene, J. D., Nystrom, L. E., Engell, A. D., Darley, J. M., & Cohen, J. D. (2004). The neural bases of cognitive conflict and control in moral judgment. *Neuron*, *44*(2), 389-400. doi: 10.1016/j.neuron.2004.09.027.

Habermas, T., & de Silveira, C. (2008). The development of global coherence in life narratives across adolescence: temporal, causal, and thematic aspects. *Dev. Psychol.* 44, 707–721.

Hakemulder, J. (2000). *The moral laboratory: Experiments examining the effects of reading literature on social perception and moral self-concept* (Vol. 34). John Benjamins Publishing.

Hamburger, K. (1973). *The logic of literature*. (2nd ed.), Indiana University Press, Bloomington.

Hamilton, A. F. de C., & Grafton, S. T. (2008). Action outcomes are represented in human inferior frontoparietal cortex. *Cerebral Cortex*, *18*(5), 1160-1168. doi: 10.1093/cercor/bhm150.

Han, S., Jiang, Y., Humphreys, G. W., Zhou, T., & Cai, P. (2005). Distinct neural substrates for the perception of real and virtual visual worlds. *NeuroImage*, *24*(3), 928-35. doi: 10.1016/j.neuroimage.2004.09.046.

Hasson, U., Nusbaum, H. C., & Small, S. L. (2007). Brain networks subserving the extraction of sentence information and its encoding to memory. *Cerebral cortex*, *17*(12), 2899-913. doi:10.1093/cercor/bhm016

Hauk, O., Johnsrude, I., & Pulvermüller, F. (2004). Somatotopic representation of action words in human motor and premotor cortex. *Neuron*, *41*(2), 301-307.

Heidenreich, S. M., & Turano, K. A. (2011). Where does one look when viewing artwork in a museum?. *Empirical Studies of the Arts*, *29*(1), 51-72.

Henschel, S., & Roick, T. (2013). Zusammenhang zwischen Empathie und dem Verstehen literarischer Texte. *Zeitschrift für Entwicklungspsychologie und Pädagogische Psychologie*.

Hermann, A., Schäfer, A., Walter, B., Stark, R., Vaitl, D., & Schienle, A. (2009). Emotion regulation in spider phobia: role of the medial prefrontal cortex. *Social cognitive and affective neuroscience*, *4*(3), 257-267. doi: 10.1093/scan/nsp013.

Hirstein, W. (2013). Memories of Art. *Behavioral and Brain Sciences*, *36*(02), 146-147.

Höfel, L., & Jacobsen, T. (2007). Electrophysiological indices of processing aesthetics: Spontaneous or intentional processes?. *International Journal of Psychophysiology*, *65*(1), 20-31.

Hoffner, C. A., Fujioka, Y., & Ye, J. (2009). Mass communication and society why we watch: factors affecting exposure to tragic television news. *Communication* 12, 193–216.

Hogan, P. C. (2003). *The Mind and Its Stories: Narrative Universals and Human Emotion*. Cambridge, MA: Cambridge University Press.

Hooker, C. I., Verosky, S. C., Germine, L. T., Knight, R. T., & D'Esposito, M. (2008). Mentalizing about emotion and its relationship to empathy. *Soc. Cogn. Affect. Neurosci*. 3, 204–217.

Hsu, C. T., Conrad, M., & Jacobs, A. M. (2014). Fiction feelings in Harry Potter: haemodynamic response in the mid-cingulate cortex correlates with immersive reading experience. *Neuroreport*, *25*(17), 1356-1361.

Hsu, C. T., Jacobs, A. M., Altmann, U., & Conrad, M. (2015). The magical activation of left amygdala when reading Harry Potter: An fMRI study on how descriptions of supra-natural events entertain and enchant. *PloS one*, *10*(2), e0118179.

Hynes, C. A., Baird, A. A., & Grafton, S. T. (2006). Differential role of the orbital frontal lobe in emotional versus cognitive perspective-taking. *Neuropsychologia* 44, 374–383.

Iacoboni, M. (2009). Imitation, empathy, and mirror neurons. *Annu. Rev. Psychol*. 60, 653–670.

Ishizu, T., Zeki, S., 2011. Toward a brain-based theory of beauty. PLoS One 6 (7), e21852. http://dx.doi.org/10.1371/journal.pone.0021852.

Jackson, P. L., & Decety, Jean. (2004). Motor cognition: a new paradigm to study self-other interactions. *Current Opinion in Neurobiology*, *14*(2), 259-263. doi: 10.1016/j.conb.2004.01.020.

Jacobs, A. M. (2015a). Neurocognitive poetics: methods and models for investigating the neuronal and cognitive-affective bases of literature reception. *Frontiers in human neuroscience*, *9*.

Jacobs, A. M. (2015b). Towards a neurocognitive poetics model of literary reading. *Towards a cognitive neuroscience of natural language use*, 135-159.

Jacobs, A. M., & Lüdtke, J. (2017). Immersion into narrative and poetic worlds: A neurocognitive poetics perspective. *The handbook of narrative absorption*, 69–96.

Jacobs, A. M., & Willems, R. M. (2017). The Fictive Brain: Neurocognitive Correlates of Engagement in Literature. *Review of General Psychology.* Advance online publication. http://dx.doi.org/10.1037/gpr0000106

Jacobs, A. M., Lüdtke, J., & Meyer-Sickendiek, B. (2013). Foregrounding/Backgrounding: Bausteine einer Neurokognitiven Poetik [Foregrounding/ backgrounding: Building blocks of a neurocognitive poetics model]. In B. Meyer Sickendiek & F. Reents (Eds.), *Stimmung und Methode* [*Mood and Method*] (pp. 63–94). Tübingen, Germany: Mohr Siebeck.

Jacobs, A.M., (2011). Neurokognitive Poetik: Elemente eines Modells des literarischen Lesens (Neurocognitive poetics: Elements of a model of literary reading). In R. Schrott & A.M. Jacobs, *Gehirn und Gedicht: Wie wir unsere Wirklichkeiten konstruieren.* (pp. 492-524). München, Germany: Carl Hanser Verlag.

Jakesch, M., & Leder, H. (2009). Finding meaning in art: Preferred levels of ambiguity in art appreciation. *Quarterly Journal of Experimental Psychology (2006)*, *62*(11), 2105–2112. http://doi.org/10.1080/17470210903038974

Jakobson, R. (1960). Linguistics and poetics. In *Style in language* (350-377). MA: MIT Press.

Jakobson, R. (1979). *Was ist Poesie?* In: *Poetik. Ausgewählte Aufsätze 1921-1971. Hg. v. Elmar Holenstein*, Frankfurt a.M.: Suhrkamp 1979, 67-82.

Jucker, J. L., Barrett, J. L., & Wlodarski, R. (2014). “I Just Don'T Get it”: Perceived Artists' Intentions Affect Art Evaluations. *Empirical Studies of the Arts*, *32*(2), 149-182.

Kant, I. (2001*) Kritik der Urteilskraft [Critique of Judgement]*. Hamburg: Meiner. (Orig. published 1790).

References

Kawabata, H., & Zeki, S. (2004). Neural correlates of beauty. *Journal of neurophysiology*, *91*(4), 1699–705. doi:10.1152/jn.00696.2003

Kidd, D. C., & Castano, E. (2013). Reading literary fiction improves theory of mind. *Science*, *342*(6156), 377-380.

Kirk, U., 2008. The neural basis of object-context relationships on aesthetic judgment. *PLoS One,* 3 (11), e3754. http://dx.doi.org/10.1371/journal.pone.0003754.

Klucharev, V., Hytönen, K., Rijpkema, M., Smidts, A., & Fernández, G. (2009). Reinforcement learning signal predicts social conformity. *Neuron*, *61*(1), 140-51. doi: 10.1016/j.neuron.2008.11.027.

Klüger, R. (2006). *Gelesene Wirklichkeit: Fakten und Fiktionen in der Literatur*. Wallstein Verlag.

Koopman, E. M. E. (2015). Empathic reactions after reading: The role of genre, personal factors and affective responses. *Poetics*, *50*, 62-79.

Koopman, E. M. E. (2015). Empathic reactions after reading: The role of genre, personal factors and affective responses. *Poetics*, *50*, 62-79.

Koopman, E. M. E. (2016). Effects of “literariness” on emotions and on empathy and reflection after reading. *Psychology of Aesthetics, Creativity, and the Arts*, *10*(1), 82.

Koopman, E. M. E. (2016). Effects of “literariness” on emotions and on empathy and reflection after reading. *Psychology of Aesthetics, Creativity, and the Arts*, *10*(1), 82.

Kreplin, U., & Fairclough, S. H. (2015). Effects of self-directed and other-directed introspection and emotional valence on activation of the rostral prefrontal cortex during aesthetic experience. *Neuropsychologia*, *71*, 38-45.

Kuchinke, L., Jacobs, A. M., Grubich, C., Võ, M. L.-H., Conrad, M., & Herrmann, M. (2005). Incidental effects of emotional valence in single word processing: an fMRI study. *Neuroimage* 28, 1022–1032.

Kuchinke, L., Schneider, D., Kotz, S. A., & Jacobs, A. M. (2011). Spontaneous but not explicit processing of positive sentences impaired in Asperger's syndrome: pupillometric evidence. *Neuropsychologia* 49, 331–338.

Kühn, S. & Gallinat, J. (2012). The neural correlates of subjective pleasantness. Neuroimage, 61, 289-294.

Lacey, S., Hagtvedt, H., Patrick, V. M., Anderson, A., Stilla, R., Deshpande, G., ... & Sathian, K. (2011). Art for reward's sake: Visual art recruits the ventral striatum. *Neuroimage*, *55*(1), 420-433.

Lamarque, P. & Olsen, S.H. (1994): *Truth, Fiction, and Literature. A Philosophical Perspektive.* Oxford: Clarendon.

Lamarque, P. (1981). How can we fear and pity fictions?. *The British Journal of Aesthetics*, *21*(4), 291.

Lane, R. D., Reiman, E. M., Bradley, M. M., Lang, P. J., Ahern, G. L., Davidson, R. J., & Schwartz, G. E. (1997). Neuroanatomical correlates of pleasant and unpleasant emotion. *Neuropsychologia* 35, 1437–1444.

Lazarus R. S. (1991). *Emotion and adaptation.* New York, NY: Oxford University Press.

Leder, H., & Nadal, M. (2014). Ten years of a model of aesthetic appreciation and aesthetic judgments: The aesthetic episode–Developments and challenges in empirical aesthetics. *British Journal of Psychology*, *105*(4), 443-464.

Leder, H., Belke, B., Oeberst, A., & Augustin, D. (2004). A model of aesthetic appreciation and aesthetic judgments. *British Journal of Psychology*, *95*, 489–508.

Leder, H., Gerger, G., Brieber, D., & Schwarz, N. (2014). What makes an art expert? Emotion and evaluation in art appreciation. *Cognition and Emotion, 28(6),* 1137-1147.

References

Leder, H., Markey, P. S. & Pelowski, M. (2015). Aesthetic Emotions to Art - what they are and what makes them special. Comment on "The Quartet Theory of Human Emotions: An Integrative and Neurofunctional Model" by S. Koelsch et al. Physics of Life Review, 67-70. doi: 10.1016/j.plrev.2015.04.037.

Lipps, T. (1903). *Psychologie des Schönen und der Kunst* [Psychology of beauty and the arts]. Hamburg, Germany: Verlag Leopold Voss.

Mar, R. A. (2004). The neuropsychology of narrative: Story comprehension, story production and their interrelation. *Neuropsychologia, 42*, 1414-1434.

Mar, R. A. (2011). The neural bases of social cognition and story comprehension. *Annual review of psychology*, *62*, 103-34. doi:10.1146/annurev-psych-120709-145406

Mar, R. A., & Oatley, K. (2008). The Function of Fiction is the Abstraction and Simulation of Social Experience. *Psychological Science*, *3*(3), 173-192.

Mar, R. A., Kelley, W. M., Heatherton, T. F., & Macrae, C. N. (2007). Detecting agency from the biological motion of veridical vs animated agents. *Social cognitive and affective neuroscience*, *2*(3), 199-205. doi: 10.1093/scan/nsm011.

Mar, R. A., Oatley, K., Djikic, M., & Mullin, J. (2011). Emotion and narrative fiction: Interactive influences before, during, and after reading. *Cognition & emotion*, *25*(5), 818-833.

Mar, R. A., Oatley, K., Hirsh, J., Delapaz, J., & Peterson, J. (2006). Bookworms versus nerds: Exposure to fiction versus non-fiction, divergent associations with social ability, and the simulation of fictional social worlds. *Journal of Research in Personality*, *40*(5), 694-712. doi: 10.1016/j.jrp.2005.08.002.

Martindale, C., & Dailey, A. (1995). I.A. Richards revisited: do people agree in their interpretations of literature? *Poetics* 23, 299–314.

Mason, R. A., & Just, M. A. (2009). The role of the theory-of-mind cortical network in the comprehension of narratives. *Lang. Linguist. Compass* 3, 157–174.

Masten, C. L., Morelli, S. A., & Eisenberger, N. I. (2011). Neuroimage an fMRI investigation of empathy for "social pain" and subsequent prosocial behavior. *Neuroimage* 55, 381–388.

McAdams Dan, P. (2001). The psychology of life stories. *Rev. Gen. Psychol.* 5, 100–122.

McRae, K., Ochsner, K. N., Mauss, I. B., Gabrieli, J. J. D., & Gross, J. J. (2008). Gender Differences in Emotion Regulation: An fMRI Study of Cognitive Reappraisal. *Group Processes & Intergroup Relations*, *11*(2), 143-162. doi: 10.1177/1368430207088035.

Meinong, A. (1983). On Assumptions, trans. *James Heanue, 2nd edn. Berkeley: University of California Press (originally published 1910).*

Miall, D. S., & Kuiken, D. (1994). Foregrounding, defamiliarization, and affect: response to literary stories. *Poetics* 22, 389–407.

Mineka, S., Davidson, M., Cook, M., & Keir, R. (1984). Observational conditioning of snake fear in rhesus monkeys. *Journal of Abnormal Psychology 93*(4), 355-372.

Mitchell, J. P., Banaji, M. R., & Macrae, C. N. (2005). The link between social cognition and self-referential thought in the medial prefrontal cortex. *Journal of cognitive neuroscience*, *17*(8), 1306–15. doi:10.1162/0898929055002418

Moors, A., Ellsworth, P. C., Scherer, K. R., & Frijda, N. H. (2013). Appraisal theories of emotion: State of the art and future development. *Emotion Review*, *5*(2), 119-124.

Morelli, S. A., & Lieberman, M. D. (2013). The role of automaticity and attention in neural processes underlying empathy for happiness, sadness, and anxiety. *Frontiers in human neuroscience*, *7*, 160. doi:10.3389/fnhum.2013.00160

Mukařovský, J. (1970). Standard language and poetic language. *Chapters from the history of Czech functional linguistics*.

References

Nadal, M. (2013). The experience of art: Insights from neuroimaging. In Stanley Finger, Dahlia W. Zaidel, François Boller and Julien Bogousslavsky, editors: Progress in Brain Research, Vol. 204, Amsterdam: The Netherlands, 2013, pp. 135-158.

Nieuwenhuys, R.,Voogd, J., & Van Huijzen, C. (2007). *The human central nervous system: A synopsis and Atlas* (4th ed.), Springer, Berlin Heidelberg.

Northoff, G., & Bermpohl, F. (2004). Cortical midline structures and the self. *Trends in cognitive sciences*, *8*(3), 102–7. doi:10.1016/j.tics.2004.01.004

Nummenmaa, L., Hirvonen, J., Parkkola, R., & Hietanen, J. K. (2008). Is emotional contagion special? An fMRI study on neural systems for affective and cognitive empathy. *Neuroimage* 43, 571–580.

Oatley, K. (1995). A taxonomy of the emotions of literary response and a theory of identification in fictional narrative. *Poetics*, *23*(1-2), 53-74.

Oatley, K. (1999). Why fiction may be twice as true as fact: Fiction as cognitive and emotional simulation. *Review of General Psychology*, *3*(2), 101.

Oatley, K. (2016). Fiction: Simulation of social worlds. *Trends in cognitive sciences*, *20*(8), 618-628.

Oatley, K., & Jenkins, J. M. (1996). *Understanding emotions*. Cambridge, Mass: Blackwell Publishers.

Oatley, K., & Olson, D. (2010). Cues to the imagination in memoir, science, and fiction. *Review of General Psychology*, *14*(1), 56-64. doi: 10.1037/a0018775.

Panksepp, J. (2008). The power of the word may reside in the power of affect. *Integrative Psychological and Behavioral Science*, *42*(1), 47-55.

Parkinson, C., Sinnott-Armstrong, W., Koralus, P. E., Mendelovici, A., McGeer, V., & Wheatley, T. (2011). Is morality unified? Evidence that distinct neural systems underlie moral judgments of harm, dishonesty, and disgust. *J. Cogn. Neurosci.* 23, 3162–3180.

Paulus, C. (2009).The Saarbruecken personality questionnaire on empathy: psychometric evaluation of the German version of the Interpersonal Reactivity Index. Available online at: http://www.uni-saarland.de/fak5/ezw/personal/paulus/empathy/SPF_Artikel.pdf

Peelen, M. V., & Downing, P. E. (2005). Selectivity for the human body in the fusiform gyrus. *Journal of neurophysiology*, *93*(1), 603-608.

Perani, D., Fazio, F., Borghese, N. A., Tettamanti, M., Ferrari, S., Decety, J., et al. (2001). Different brain correlates for watching real and virtual hand actions. *NeuroImage*, *14*(3), 749-758. doi: 10.1006/nimg.2001.0872.

Phan, K. L., Wager, T. D., Taylor, S. F., & Liberzon, I. (2004). Functional neuroimaging studies of human emotions. *CNS Spectr*. 9, 258–266.

Pino, M. C., & Mazza, M. (2016). The use of "literary fiction" to promote mentalizing ability. *PloS one*, *11*(8), e0160254.

Preston, S. D., & de Waal, F. B. M. (2002). Empathy: its ultimate and proximate bases. *Behav. Brain sci*. 25, 1–72.

Pulvermüller, F. (2005). Brain mechanisms linking language and action. *Nature reviews. Neuroscience*, *6*(7), 576.

Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., & Shulman, G. L. (2001). A default mode of brain function. *Proceedings of the National Academy of Sciences of the United States of America*, *98*(2), 676-82.

Raney, A. A. (2002). Moral judgment as a predictor of enjoyment of crime drama. *Media Psychol*. 4, 305–322.

Raney, A. A., & Bryant, J. (2002). Moral judgment and crime drama: An integrated theory of enjoyment. *Journal of communication, 52*(2), 402-415.

Raposo, A., Vicens, L., Clithero, J. a, Dobbins, I. G., & Huettel, S. a. (2010). Contributions of frontopolar cortex to judgments about self, others and relations. *Social Cognitive and Affective Neuroscience*. doi: 10.1093/scan/nsq033.

References

Reichle, E. D., Reineberg, A. E., Schooler, J. W. (2010). Eye Movements During Mindless Reading. *Psychological Science, 21: 1300-1310.*

Reisenzein, R. (2012a). Extending the belief-desire theory of emotions to fantasy emotions. *Proceedings of the ICCM 2012*, 313-314.

Reisenzein, R. (2012b). Fantasiegefühle aus der Sicht der kognitiv-motivationalen Theorie der Emotion [Fantasy emotions from the perspective of the cognitive-motivational theory of emotion]. In S. Poppe, (Hg.), *Emotionen in Literatur und Film [Emotions in literature and film]* (S. 31-63). Würzburg: Königshausen & Neumann.

Reisenzein, R., & Junge, M. (2012). Language and emotion from the perspective of the computational belief-desire theory of emotion. *Dynamicity in emotion concepts*, *27*, 37-59.

Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Annu. Rev. Neurosci.* 27, 169–192.

Rossi, G., Mechanisms, R., Relevance, A., & Diversity, H. C. (2003). Virtual Reality: Do Not Augment Realism, Augment Relevance. *It Professional*, *IV*(1).

Roy, M., Shohamy, D., & Wager, T. D. (2012). Ventromedial prefrontal-subcortical systems and the generation of affective meaning. *Trends in cognitive sciences*, *16*(3), 147-156. doi:10.1016/j.tics.2012.01.005

Sabatinelli, D., Lang, P. J., Bradley, M. M., & Flaisch, T. (2006). The neural basis of narrative imagery: emotion and action. *Prog. Brain Res.* 156, 93–103.

Saxe, R., & Wexler, A. (2005). Making sense of another mind: the role of the right temporo-parietal junction. *Neuropsychologia* 43, 1391–1399.

Schacter, D. L., Addis, D. R., & Buckner, R. L. (2008). Episodic simulation of future events: concepts, data, and applications. *Annals of the New York Academy of Sciences*, *1124*, 39-60. doi: 10.1196/annals.1440.001.

Scherer, K. R. (1999). Appraisal theory. In T. Dalgleish & M. J. Power (Eds.), *Handbook of cognition and emotion* (pp. 637-663).

Schnell, K., Bluschke, S., Konradt, B., & Walter, H. (2011). Functional relations of empathy and mentalizing: an fMRI study on the neural basis of cognitive empathy. *Neuroimage*, *54*(2), 1743-1754.

Schooler, J. W., Reichle, E. D., & Halpern, D. V. (2004). Zoning out while reading: Evidence for dissociations between experience and metaconsciousness. In D.T. Levin (Ed.*), Thinking and seeing: Visual metacognition in adults and children* (pp. 203-226). Cambridge, MA: MIT Press.

Schramm, H., & Wirth, W. (2010). Exploring the paradox of sad-film enjoyment: the role of multiple appraisals and meta-appraisals. *Poetics* 38, 319–335.

Schulte-Rüther, M., Markowitsch, H. J., Fink, G. R., & Piefke, M. (2007). Mirror neuron and theory of mind mechanisms involved in face-to-face interactions: a functional magnetic resonance imaging approach to empathy. *J. Cogn. Neurosci.* 19, 1354–1372.

Searle, J. R. (1975). The Logical Status of Fictional Discourse. *New Literary History*, *6*(2), 319. doi: 10.2307/468422.

Sebastian, C. L., Fontaine, N. M., Bird, G., Blakemore, S. J., De Brito, S. A., McCrory, E. J., & Viding, E. (2012). Neural processing associated with cognitive and affective Theory of Mind in adolescents and adults. *Social cognitive and affective neuroscience*, *7*(1), 53-63.

Sestir, M., & Green, M. C. (2010). You are who you watch: Identification and transportation effects on temporary self-concept. *Social Influence*, *5*(4), 272-288.

Shamay-Tsoory, S. G. (2011). The neural bases for empathy. *Neuroscientist, 17*(1), 18–24. doi:10.1177/1073858410379268.

Shane, M. S., Stevens, M. C., Harenski, C. L., & Kiehl, K. a. (2009). Double dissociation between perspective-taking and empathic-concern as predictors of hemodynamic response to another's mistakes. *Social cognitive and affective neuroscience*, *4*(2), 111-8. doi: 10.1093/scan/nsn043.

Shklovsky, V., & Berlina, A. (2015). Art, as Device. *Poetics Today*, *36*(3), 151-174.

References

Shusterman, R. (1997). The end of aesthetic experience. The Journal of Aesthetics and Art Criticism, 55, 29–41.

Singer, T., Seymour, B., O'Doherty, J. P., Stephan, K. E., Dolan, R. J., & Frith, C. D. (2006). Empathic neural responses are modulated by the perceived fairness of others. *Nature, 439*(7075), 466-9. doi: 10.1038/nature04271.

Singer, T., Seymour, B., O'Doherty, J., Kaube, H., Dolan, R. J., & Frith, C. D. (2004). Empathy for pain involves the affective but not sensory components of pain. *Science* 303, 1157–1162.

Smallwood, J., Brown, K., Baird, B., & Schooler, J. W. (2012). Cooperation between the default mode network and the frontal–parietal network in the production of an internal train of thought. *Brain research*, *1428*, 60-70.

Smith, J. K., & Smith, L. F. (2001). Spending time on art. *Empirical Studies of the Arts*, *19*(2), 229-236.

Smith, M. (2009). Double Trouble: On Film, Fiction, and Narrative. *StoryWorlds: A Journal of Narrative Studies*, *1*(1), 1-23. doi: 10.1353/stw.0.0014.

Sommer, M., Meinhardt, J., Eichenmüller, K., Sodian, B., Döhnel, K., & Hajak, G. (2010). Modulation of the cortical false belief network during development. *Brain Research*, *1354*, 123-131. Elsevier B.V. doi: 10.1016/j.brainres.2010.07.057.

Sperduti, M., Arcangeli, M., Makowski, D., Wantzen, P., Zalla, T., Lemaire, S., ... & Piolino, P. (2016). The paradox of fiction: Emotional response toward fiction and the modulatory role of self-relevance. *Acta psychologica*, *165*, 53-59.

Spreng, R. N. (2012). The fallacy of a "task-negative" network. *Frontiers in psychology*, *3*, 145. doi:10.3389/fpsyg.2012.00145

Spreng, R. N., Stevens, W. D., Chamberlain, J. P., Gilmore, A. W., & Schacter, D. L. (2010). Default network activity, coupled with the frontoparietal control network, supports goal-directed cognition. *Neuroimage*, *53*(1), 303-317.

Summerfield, J. J., Hassabis, D., & Maguire, E. A. (2009). Cortical midline involvement in autobiographical memory. *NeuroImage*, *44*(3), 1188-1200. Elsevier Inc. doi: 10.1016/j.neuroimage.2008.09.033.

Summerfield, J. J., Hassabis, D., & Maguire, E. A. (2010). Differential engagement of brain regions within a “core” network during scene construction. *Neuropsychologia*, *48*(5), 1501-1509. Elsevier Ltd. doi: 10.1016/j.neuropsychologia.2010.01.022.

Talairach, J., & Tournoux, P. (1988). *Co-Planar Stereotaxic Atlas of the Human Brain*. New York, NY: Thieme.

Tan, S.-L., Spackman, M. P., & Peaslee, C. L. (2006). The effects of repeated exposure on liking and judgments of musical unity of intact and patchwork compositions. *Music Percept*. 23, 407–421.

Tavares, P., Lawrence, A. D., & Barnard, P. J. (2008). Paying attention to social meaning: an FMRI study. *Cerebral Cortex*, *18*(8), 1876-1885.

Tricomi, E., Rangel, A., Camerer, C. F., & O’Doherty, J. P. (2010). Neural evidence for inequality-averse social preferences. *Nature, 463*(7284), 1089-91. doi: 10.1038/nature08785.

Turner Jr, S. A., & Silvia, P. J. (2006). Must interesting things be pleasant? A test of competing appraisal structures. *Emotion*, *6*(4), 670-674.

Van Overwalle, F. (2009). Social cognition and the brain: a meta- analysis. *Human brain mapping*, *30*(3), 829-858.

Vartanian, O., & Goel, V. (2004). Neuroanatomical correlates of aesthetic preference for paintings. *Neuroreport*, *15*, 893–897.

Vessel, E.A., Starr, G.G. & Rubin, N. (2012) The brain on art: intense aesthetic experience activates the default mode network. *Front. Hum. Neurosci*. **6**:66. doi: 10.3389/fnhum.2012.0006

Villani, D., Morganti, F., Cipresso, P., Ruggi, S., Riva, G., & Gilli, G. (2015). Visual exploration patterns of human figures in action: an eye tracker study with art paintings. *Frontiers in Psychology*, *6*, 1636. http://doi.org/10.3389/fpsyg.2015.01636

Von Foerster, H., & Pörksen, B. (1998). Wahrheit ist die Erfindung eines Lügners. *Gespräche für Skeptiker, Carl Auer Systeme-Verlag, Heidelberg*.

Von Schlippe, A., & Schweitzer, J. (2007). *Lehrbuch der systemischen Therapie und Beratung*. Vandenhoeck & Ruprecht.

Wallentin, M., Nielsen, A. H., Vuust, P., Dohn, A., Roepstorff, A., & Lund, T. E. (2011). Amygdala and heart rate variability responses from listening to emotionally intense parts of a story. *Neuroimage*, *58*(3), 963-973.

Wallentin, M., Nielsen, A. H., Vuust, P., Dohn, A., Roepstorff, A., & Lund, T. E. (2011). BOLD response to motion verbs in left posterior middle temporal gyrus during story comprehension. *Brain and language*, *119*(3), 221-225.

Walter, H. (2012). Social Cognitive Neuroscience of Empathy: Concepts, Circuits, and Genes. *Emotion Review*, *4*(1), 9 –17. doi:10.1177/1754073911421379

Walton, K. L. (1978). Fearing fictions. *The Journal of Philosophy*, *75*(1), 5-27.

Walton, K. L. (1990). *Mimesis as make-believe: On the foundations of the representational arts*. Harvard University Press.

Whitehead, C., Marchant, J. L., Craik, D., & Frith, C. D. (2009). Neural correlates of observing pretend play in which one object is represented as another. *Social cognitive and affective neuroscience, 4*(4), 369-78. doi: 10.1093/scan/nsp021.

Willems, R. M., Clevis, K., & Hagoort, P. (2010). Add a picture for suspense: neural correlates of the interaction between language and visual information in the perception of fear. *Social cognitive and affective neuroscience, 6*(4), 404-416. doi: 10.1093/scan/nsq050.

Woolley, J. D., & Cox, V. (2007). Development of beliefs about storybook reality. *Developmental Science*, *10*(5), 681-693. doi: 10.1111/j.1467-7687.2007.00612.x.

Woolley, J. D., & Wellman, H. M. (1990). Young Children ' s Understanding Nonrealities, and Appearances of Realities,. *Child Development*, *61*(4), 946-961.

Xu, J., Kemeny, S., Park, G., Frattali, C., & Braun, A. (2005). Language in context: emergent features of word, sentence, and narrative comprehension. *NeuroImage*, *25*(3), 1002-15. doi:10.1016/j.neuroimage.2004.12.013

Yarkoni, T., Speer, N. K., & Zacks, J. M. (2008). Neural substrates of narrative comprehension and memory. *NeuroImage*, *41*(4), 1408-25. doi:10.1016/j.neuroimage.2008.03.062

Zillmann, D. (1994). Mechanisms of emotional involvement with drama. *Poetics* 23, 33–51.

Zillmann, D., Taylor, K., & Lewis, K. (1998). News as nonfiction theater: how dispositions toward the public cast of characters affect reactions. *J. Broadcast. Electron. Media* 42, 153–169.

Zink, C. F., Pagnoni, G., Martin, M. E., Dhamala, M., & Berns, G. S. (2003). Human striatal response to salient nonrewarding stimuli. *Journal of Neuroscience*, *23*(22), 8092-8097. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12954871.

Zwaan, R. A. (1993). *Aspects of literary comprehension: A cognitive approach* (Vol. 29). John Benjamins Publishing.

Zwaan, R. A. (1994). Effect of genre expectations on text comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *20*(4), 920-933. doi: 10.1037/0278-7393.20.4.920.

Zysset, S., Huber, O., Ferstl, E., von Cramon, D.Y., 2002. The anterior frontomedian cortex and evaluative judgment: an fMRI study. *Neuroimage* 15, 983–991.

Appendix 1

List of stimuli used in Chapter 3: Fact vs fiction - how paratextual information shapes our reading processes

Story - negative valence	Sentences	Words	different Words	Syllables	Story - neutral valence	Sentences	Words	different Words	Syllables
Ein Astronaut nahm an seiner ersten Mission teil. Die Crew befand sich bereits seit einigen Tagen in einer Umlaufbahn um die Erde. Als die Außenhülle der Raumfähre von einem Stück Weltraumschrott durchbohrt wurde, zersplitterte ein Teil und der Mann - ohne Schutz vor der eisigen Kälte und ohne Sauerstoff - starb.	3	51	42	74	Ein Astronaut, der sich auf dem Weg ins All befand, kontrollierte kurz vor dem Start noch einmal alle technischen Geräte. Nachdem er festgestellt hatte, dass alles einwand-frei war, meldete er dies dem Tower, der ihm die Startfreigabe erteilte. Der Astronaut bestätigte die Nachricht und leitete dann den Start ein.	3	49	40	70
Ein Mann war Berufstaucher und untersuchte in großer Tiefe eine illegale Abwasser-Einleitung eines bekannten Chemiewerkes. Als er plötzlich Angst bekam, die Gifte könnten ihm gefährlich werden, geriet er in Panik, stieg zu schnell auf und starb wenig später an der Taucherkrankheit.	2	41	38	73	Ein Taucher war Angestellter auf einer Bohrinsel, wo er die Aufgabe hatte, Ablagerungen an den Füßen der Bohrinsel unter Wasser zu entdecken und zu entfernen. Seine Schichten dauerten einige Stunden, die er auch brauchte, um die Bohrinsel in einem guten Zustand zu halten.	2	43	37	74
Ein Mann hatte vor einiger Zeit seinen Job verloren und wollte Geld sparen. Deshalb versuchte er mithilfe einer Reparaturanleitung seinen VW Käfer wieder zum Laufen zu bringen. Die Steine, auf die der Wagen aufgebockt war, rutschten zur Seite und der Wagen überrollte den Mann.	3	44	38	72	Ein Mann saß am Frühstückstisch und blätterte die Stellenangebote in verschiedenen Zeitungen durch. Er schrieb sich die Nummern einiger Autowerkstätten auf, da er eine Ausbildung als Mechaniker hatte. Nach einer weiteren Tasse Kaffee setzte er sich ans Telefon und begann zu wählen.	3	42	37	74
Ein Polizist war mit einer Sondereinheit unterwegs, um ein illegales Waffenlager zu stürmen. Er hatte jedoch nicht alle Vorsichtsmaßnahmen getroffen. Als während des Einsatzes plötzlich sein Handy klingelte, war das Überraschungsmoment nicht mehr auf seiner Seite. Das Handy-Klingeln machte den Polizisten zu einem einfachen Ziel.	4	45	41	88	Ein Sicherheitsbeamter stand vor einem Geschäft und beobachtete die vorübergehenden Menschen. Er war so in Gedanken versunken, dass er das Handyklingeln erst nicht hörte. Als er schließlich abnahm, hörte er die Stimme seiner Frau. Sie erinnerte ihn daran, dass sie heute Abend zum Essen eingeladen waren.	4	46	40	79

Appendix 1

Ein Mann hielt eine Pistole in der Hand und auf den ersten Blick sah alles nach Selbstmord aus. Als aber die Polizei den Kassettenrekorder einschaltete und einen Abschiedsgruß von einem Schuss gefolgt hörte, war klar, dass jemand die Kassette an die entsprechende Stelle zurückgespult haben musste - also war es kein Selbstmord.	2	52	45	80	Ein Mann nahm ein Protokoll, das er während einer Arbeitssitzung auf einen Zettel geschrieben hatte, auf ein Diktiergerät auf. Danach spulte er das Band zurück und legte das Gerät auf den Schreibtisch seiner Sektretärin mit einer kurzen Notiz daneben, das Ganze bis Morgen ins Reine zu schreiben.	2	47	37	76
Da im Krankenhaus nichts mehr für einen Mann getan werden konnte, wurde er nach Hause verlegt und dort von einer Lungenmaschine beatmet. Als seine Frau mittags heimkam und der Fahrstuhl streikte, ahnte sie bereits, dass der Strom ausgefallen sein musste. Aber auch eine Lungenmaschine funktioniert nicht ohne Strom.	3	48	44	72	Nach einer Routineuntersuchung beim Arzt beschloss ein Mann noch eine Tasse Tee trinken zu gehen. Zufällig traf er seine Nachbarin, die sich für das gleiche Lokal entschieden hatte. Sie unterhielten sich über ihre Kinder und Geschichten aus der Nachbarschaft, bis ihnen die Ideen ausgingen.	3	44	42	73
Ein Mann hatte in Afrika Urlaub gemacht und war dort mehrmals gestochen worden. Zu Hause entwickelten sich an den Einstichen riesige Pickel, die er mit allerlei Cremes behandelte. Als er eines Morgens vor dem Spiegel stand und an ihnen herumdrückte, entschlüpften den Pickeln kleine Maden.	3	45	41	75	Eine Frau flog nach Afrika und wanderte dort durch die Naturparks. Manchmal fuhr sie auch in eine Stadt und besuchte eines der Museen, die afrikanische Kunst ausstellten. Nach zwei Wochen war der Urlaub zu Ende, sie packte ihre Sachen in den Koffer und reiste ab.	3	45	37	63
Eine Urlauberin hatte sich beim Wracktauchen verschätzt und war zu lange in zu großer Tiefe geblieben. Während sie fasziniert die Überreste eines gesunkenen Piratenschiffs bestaunte, verlor sie Orientierung und Zeitgefühl, so dass sie zu spät merkte, dass ihre Pressluft zu Ende ging.	2	42	36	71	Während eines Urlaubes am Meer lernte eine Frau zu tauchen, wie ihre Freunde es ihr empfohlen hatten. Nachdem sie einen kurzen Theoriekurs bestanden und etwas praktische Erfahrung mit einem eigenen Trainer gesammelt hatte, war sie nun in der Lage, alleine zu tauchen.	2	42	39	69
Ein Mann hatte sich in der Wüste verlaufen. Da er keinerlei Orientierungspunkte hatte, steckte er an alle Kakteen, an denen er vorbeikam, ein kleines Stück Papier. Als er nach Tagen ohne Wasser völlig entkräftet einen Kaktus mit einer seiner Markierungen sah, wusste er, dass er im Kreis gelaufen war und ergab sich seinem Schicksal.	3	54	45	85	Ein Mann war einer der Teilnehmer eines Wüstenrennens. Die zu überwindende Distanz waren siebzig Kilometer in drei Tagen, wobei er sich vorgenommen hatte, sich die Zeit und seine Energie gut einzuteilen. So haushaltete er entsprechend mit seinen Vorräten an Nahrung und Wasser und schaffte es, wie geplant, nach drei Tagen ans Ziel.	3	52	45	89

Appendix 1

An seinem 50. Geburtstags beschloss ein Mann seine Frau zu töten. Nach einem gemeinsamen Restaurantbesuch erschoss er sie auf der Fahrt nach Hause. Als er sie ins Haus trug und einige Freunde, die seine Frau heimlich eingeladen hatte, ihn überraschten, drehte er sofort um und erschoss sich ebenfalls.	4	48	40	74	An seinem 45. Geburtstag beschloss ein Mann, seine Frau zum Essen einzuladen. Nach einem gemeinsamen Restaurantbesuch, fuhren sie nach Hause. Als er mit ihr in das Haus ging, hatte er schon einige Nachrichten seiner Freunde auf dem Anrufbeantworter, den seine Frau vorher angeschaltet hatte.	4	44	39	73
Eine Frau hatte ein 6 Monate altes Baby. Da sie nach mehreren Nächten, die das Baby nicht geschlafen hatte, nicht mehr wusste, was sie mit ihm machen sollte, um selbst Schlaf zu finden, legte sie das Baby auf den Bauch, entgegen den Empfehlungen ihres Arztes. So starb es am plötzlichen Kindstod.	3	51	43	73	Eine Frau hatte vor kurzem ein Baby bekommen. Während sie sich daran machte die Wohnung aufzuräumen, legte sie das Kind in sein Bett, wo es sofort einschlief. Als sie ihre Arbeit nach zwei Stunden beendet hatte, ging sie in die Küche und begann Gemüse für das Mittagessen klein zu schneiden.	3	50	43	71
Während einer Reserveübung mit scharfer Munition wollte ein Leutnant, seinen Soldaten demonstrieren, wie sie sich gegen einen Angriff mit einem Messer verteidigen konnten. Dazu näherte er sich leise einem Soldaten, der in Gedanken versunken war. Der unerwartete Angriff erschreckte diesen so sehr, dass er sein Gewehr, das noch nicht gesichert war, auf den Leutnant richtete und abdrückte.	3	57	48	102	Ein junger Soldat saß am Boden und reinigte seine Ausrüstung. Nachdem er alles erledigt hatte, meldete er sich bei seinem Vorgesetzten ab und machte sich auf den Weg in den Aufenthaltsraum zu den Kameraden. Er setzte sich an einen Tisch und begann einen Brief nach Hause zu schreiben, in dem er von der letzten Woche berichtete.	3	56	44	84
Ein Fußballfan war mit der Fahne seines Vereins während der Fahrt auf das Dach eines Doppeldeckerbusses gestiegen, der den Fanclub nach Hause bringen sollte. Der Zeitpunkt war unglücklich gewählt, denn als der Bus kurz darauf unter einer Brücke hindurch fuhr, wurde der Fan vom Dach gefegt.	2	46	40	70	Ein Fussballfan war zu dem letzten Spiel seines Vereins in dieser Saison gegangen. Als er sich eine Karte löste, traf er noch weitere Fans des gleichen Vereins, die auch das Spiel sehen wollten, und so kauften sie sich Karten für nebeneinanderliegende Plätze und warteten dann auf Spielbeginn.	2	47	42	73
Eine Frau wollte sich an ihrem Mann rächen. Er hatte sie betrogen. Da sie ihn immer schon dafür gehasst hatte, dass er das Rauchen nicht für sie aufgeben wollte, fesselte sie ihn im Schlaf und beklebte seinen gesamten Körper mit Nikotinpflastern. Nach einigen Stunden war der Mann vergiftet.	4	48	40	73	Eine Frau traf sich Mittags mit ihrem Mann. Sie tranken gemeinsam Kaffee und rauchten ein paar Zigaretten, während sie sich unterhielten. Nach ungefähr zwei Stunden riefen sie den Kellner herbei um zu zahlen. Nachdem sie gezahlt und das Lokal verlassen hatten, gingen beide nach Hause.	4	45	39	73

Appendix 1

Um von Kuba nach Amerika zu kommen, benutzte ein junger Mann den Schlauch eines Traktorreifens. Da die Amerikanischen Behörden niemanden des Landes verweisen können, wenn er verletzt ist, schoss sich der Kubaner selbst in den Oberschenkel. Dabei traf er eine Hauptschlagader und verblutete, bevor er die rettende Küste erreichen konnte.	3	50	46	90	Um von Belgien nach England zu kommen, benutzte eine junge Frau die Fähre. Sie blieb erst eine Weile an Deck und legte sich dann über Nacht auf eine Ruheliege, wo sie fast die gesamte Fahrt verschlief. Sie frühstückte am nächsten Morgen in der kleinen Bord-Cafeteria, kurz bevor die Fähre den Zielort erreichte.	3	52	45	72
Ein Geisteskranker wollte auf einer Eröffnungsfeier alle Gäste vergiften. Dazu hatte er Gift in die Eiswürfel eingebracht. Es überlebte nur ein Gast: eine junge Mutter, die schon sehr früh die Veranstaltung verlassen musste und ihr Getränk so schnell herunterkippte, dass die darin befindlichen Eiswürfel im Glas zurück blieben.	3	48	42	82	Ein Mann war auf die Eröffnungsfeier einer Boutique eingeladen. Da ihm kein besonderes Geschenk einfiel, brachte er eine Eismaschine mit, um bei der Getränkezubereitung zu helfen. Nachdem er einige Gläser getrunken hatte, begann er, frisches Eis zuzubereiten. Die Gäste nutzten es, sobald es fertig war.	4	45	40	82
Ein junger Mann stieg in ein Taxi, nannte dem Fahrer sein Ziel und bat um Eile. Kurz darauf wurde er erschossen. Sein Ziel war das Haus des Taxifahrers. Dieser vermutete schon lange, dass seine Frau einen Liebhaber hatte. Er war sich augenblicklich sicher, was zu tun war.	5	47	41	66	Ein Mann hatte sich ein Taxi gerufen. Als es eintraf, setzte er sich auf die Rückbank und nannte sein Ziel. Die Fahrt dauerte eine halbe Stunde. Am Ziel angekommen erwartete ihn schon seine Frau. Sie besuchten zusammen ein Museum und machten sich anschließend gemeinsam auf den Heimweg.	5	47	40	68
Ein Mann war sturzbetrunken von einer Party nach Hause gefahren. Auf dem Heimweg hatte er jemanden überfahren und Fahrerflucht begangen. Zu Hause angekommen wurde er sich seiner Tat bewusst. Er fuhr mit dem Auto in die Garage, befestigte einen Schlauch am Auspuff, führte diesen ins Wageninnere, setzte sich ans Steuer und ließ den Motor an.	4	55	49	88	Ein Mann war auf dem Heimweg von einer Firmenfeier. Er fuhr auf der Landstraße in das nahegelegene Dorf, in dem er wohnte. Zu Hause angekommen, parkte er seinen Wagen in der Garage und ging ins Haus. Dort fütterte er noch seine Katze und begann dann alle Rolläden herunter zu lassen.	4	50	41	73
Ein junger Mann war mit einem Fanbus auf dem Weg zu einem Eishockeyspiel. Während der Pause ging er an einer Raststätte zur Toilette. Die Tür klemmte. Als er sich endlich befreien konnte, war der Bus bereits ohne ihn abgefahren. Volltrunken setzte er die Reise auf der Autobahn zu Fuß fort und wurde von einem Auto erfasst.	5	56	46	80	Ein junger Mann fuhr an den Wochenenden regelmäßig mit den öffentlichen Verkehrsmitteln zu Fußballspielen. Während der Spielpause holte er sich meist etwas zu trinken und zu essen. Manchmal benutzte er dann noch die Toilette. Wenn die zweite Spielhälfte begann, stand er wieder an seinem Platz. Er schaute jedes Spiel bis zum Ende an.	5	53	46	82

Appendix 1

Eine Frau verbarrikadierte sich während der Abwesenheit ihres Mannes aus panischer Angst vor Einbrechern in ihrer Villa. Eines Abends gab es einen Kurzschluss und innerhalb von Minuten stand die Villa in Flammen. Die Feuerwehr konnte nicht schnell genug helfen, da alle Zugänge mehrfach gesichert waren.	3	45	42	79	Eine Frau schaffte Ordnung im gemeinsamen Haus, während ihr Mann wegen einer Kur abwesend war. Sie nutzte jeden Abend und hielt sich genau an die Pläne, die sie mit ihrem Mann besprochen hatte. Als der Mann von der Kur zurückkehrte war sie mit der Aufräumaktion fertig.	3	46	36	67
Spät abends traf sich eine Gruppe Jugendlicher, um sich gegenseitig ihre Stärke zu beweisen. Die Aufgabe bestand darin, auf einer Brücke stehend, einen Baumstamm möglichst weit über die Fahrbahn zu werfen. Der Abwurf eines Mitstreiters missglückte und der Baumstamm flog direkt in die Fensterscheibe eines unter der Brücke vorbeifahrenden Autos. Die Fahrerin verstarb.	4	53	43	92	Ein paar Jugendliche begegneten sich abends an einer Brücke. Dort beobachteten sie gemeinsam die fahrenden Autos und redeten über dies und das. Als es später wurde, versiegten die Gespräche nach und nach, so dass sich die Jugendlichen schließlich darauf einigten heimzugehen. Sie verabredeten sich für die nächsten Tage und gingen in verschiedene Richtungen davon.	4	54	45	97
Eine junge Frau, die man in einem Waldstück fand, war einem Mord zum Opfer gefallen. Der Täter hatte den Mord lange geplant. Für sein Vorhaben reichte ein wenig Schnee, den er aus einer nahen Skisporthalle entwendet hatte. Um sie spurlos zu töten, stopfte er ihr Schnee in den Rachen, woraufhin sie erstickte.	4	52	43	75	Eine junge Frau machte sich früh morgens auf, um im nahe gelegenen Wald joggen zu gehen. Sie trug eine warme Mütze, denn es lag immer noch etwas Schnee. Als ihr Kilometerzähler die Zahl fünf anzeigte, drehte sie um und lief zurück nach Hause. Nach einem kurzen Frühstück ging sie zur Arbeit.	4	51	46	70
Ein maßloser, gieriger Sohn reicher Eltern inszenierte seine eigene Entführung. Als Beweis dafür, dass es den Erpressern ernst war, schnitt er einem Toten im Leichenschauhaus den kleinen Finger ab, steckte ihm seinen Ring an und schickte ihn an seine Eltern. Nach Erhalt des Lösegeldes verschwand er auf Nimmerwiedersehen.	3	48	44	82	Ein Sohn wohlhabender Eltern ging auf eine Privatschule. Seine Leistungkurse waren Chemie und Biologie, was seiner Meinung nach die beste mögliche schulische Ausbildung für sein später geplantes Medizinstudium war. Er bemühte sich um eine gute Vorbereitung auf anstehende Prüfungen und lernte deshalb oft in der Bibliothek, weil er hier weniger abgelenkt war.	3	52	47	97
Ein Mann wollte eine Marienstatue schützen, die er seit Jahren anbetete. Sie stand unter einem Baum, der im Sturm umzustürzen drohte. Beim Versuch, das Seil, mit dem er den Baum stabilisieren wollte, im Wipfel des Baumes zu befestigen, stürzte er ab. Die gute Tat bezahlte er mit seinem Leben.	4	49	41	74	Ein Mann wollte einen Obstbaum etwas schützen, damit er weniger von Schädlingen befallen werden konnte. Er informierte sich über die entsprechenden Maßnahmen und wägte sie gegeneinander ab. Dann entschied er sich für ein Netz. Dieses besorgte er im Baumarkt und breitete es dann über der Krone des Baumes aus.	4	49	42	80

Appendix 1

Eine Krankenschwester war von der Stationsleitung beauftragt worden, am Wochenende den großen Sterilisationsschrank zu reinigen. Sie nahm diesen Auftrag sehr ernst und kroch in den Schrank, um ihn wirklich gründlich zu putzen. Auf einmal fiel die Schranktür zu. Da niemand ihre Schreie hörte, erstickte sie grausam.	4	46	43	74	Eine Krankenschwester machte sich nach ihrer Arbeit daran ihre Unterlagen zu sortieren und aufzuräumen. Nachdem sie die Patientendaten aktualisiert und verstaut hatte, hängte sie ihren Kittel in den Schrank. Auf dem Weg nach draußen verabschiedete sie ihre Kollegen. Draußen startete sie ihren Wagen und fuhr nach Hause.	4	47	38	82
Während der Demonstration eines neu entwickelten, superstarken Magneten zur Metallsortierung auf dem Schrottplatz starb eine Frau. Sie hatte sich aufgrund mangelnder Warnhinweise auf das Gelände gewagt. Die Frau hatte einen Herzschrittmacher, der durch den Magneten gestört wurde. Dadurch hörte ihr Herz auf, zu schlagen.	4	44	38	78	Eine Frau arbeitete in einer Müllaufbereitungsanlage. Ihre Aufgabe bestand zum Großteil darin, Papier von Plastik zu trennen. Die Maschinen waren dabei so konstruiert, dass sie ihr mit einem Hinweiston signalisierten, wenn ein Vorgang abgeschlossen war. Danach konnte die Frau den nächsten Arbeitsgang starten.	4	43	42	80
Ein Soldat war einer von sechs Überlebenden seiner Einheit. Sie versteckten sich im Gebüsch vor den feindlichen Truppen. In Todesangst sollte ihm das Foto seiner Frau Kraft zum Durchhalten geben. Doch als er die Brusttasche öffnete, verriet das Geräusch dem Feind das Versteck. Weil er das Foto ansehen wollte, mussten sechs Männer sterben.	5	53	46	85	Ein Soldat wohnte mit seinen vier Kameraden in einer Kaserne. An den Wänden seines Zimmers hingen bereits einige Fotos. Ein paar andere Bilder von seiner Frau wollte er noch in Alben sortieren. Als er damit bagann, stellte er fest, dass er einige der Fotos wohl schon an einem anderen Tag sortiert haben musste.	4	53	45	82
Ein junges Ehepaar wohnte am Meer. Der Ehemann fuhr jeden Abend nach Sonnenuntergang von der Arbeit nach Hause. Der Weg führte über eine steile, kurvige Straße. Weil die Ehefrau die Straßenmarkierung manipuliert hatte, flog ihr Mann aus der Kurve und stürzte ins Meer. Da die Versicherung zunächst keinen Verdacht schöpfte, kassierte sie die Versicherungsprämie.	5	54	47	90	Ein junges Ehepaar wohnte am Meer. Jeden Abend nach Sonnenuntergang ging der Ehemann entlang der Küste spazieren und hatte auch seine Turnschuhe an. Der Weg führte über eine steile gerade Straße. Weil die Frau meist schon mit dem Abendessen wartete, beeilte er sich stets. Dieses schnelle Spazierengehen waren seine Form des Sports.	5	52	50	80
Ein Fotograf war ständig auf der Suche nach spektakulären Bildern. Er versuchte in die Mitte eines Wirbelsturms, dem so genannten Auge, vorzudringen. Der Sturm wurde aber schnell so gewaltig, dass er ihn meterhoch in die Luft riss und ihm keine Chance ließ. Er verstarb.	4	44	38	67	Ein Hobbyfotograf arbeitete gern im Freien und fotografierte seltene Insekten. Fast jeden dritten Tag lag er auf der Lauer, um geeignete Motive zu finden. Seine Sammlung der letzten Jahre umfasste viele Bilder. Sein Ziel war es diese Sammlung bis an sein Lebensende zu vervollständigen.	4	44	40	72

Eine Frau hatte an ihrem Wagen neue Reifen montieren lassen. Die Mitteilung der Werkstatt, dass man bei der Montage vergessen hatte, die Reifenmuttern festzuziehen, konnte die Frau aber nicht erreichen, da sie mit ihrer Freundin "dauertelefonierte". In der ersten Kurve geriet ihr Fahrzeug außer Kontrolle und prallte gegen einen Baum.	3	50	45	84	Eine Frau fuhr nach der Arbeit in eine Autowerkstatt, um eine Routineuntersuchung durchführen zu lassen. Während die Monteure mit ihrem Auto beschäftigt waren, machte sie einen kurzen Spaziergang und telefonierte mit einer Freundin. Als sie nach einer Stunde zur Werkstatt zurückkehrte, stand ihr Auto zur Abholung bereit.	3	47	38	83
Ein Mann war Landwirt und fuhr seinen Mähdrescher in das Maisfeld, in dem seine Kinder Verstecken spielten. Als die Maschine stockte, stieg er aus, um nachzusehen, wo der Fehler lag. Als er erkannte, dass er seine Kinder überfahren hatte, nahm er sich das Leben.	3	44	36	64	Ein Landwirt, der Raps angebaut hatte, fuhr mit seinem Mähdrescher zur Ernte. Er begann früh mit der Arbeit und mähte den ganzen Tag, da er ein großes Feld bestellt hatte. Als er das Feld am Abend abgeerntet hatte, überlegte er, was er demnächst ernten könnte.	3	45	36	63
Weil ein Mann keine Ausreiseerlaubnis aus seinem Heimatland bekam, hatte ihn seine Verlobte in seinem Koffer versteckt und als Luftfracht aufgegeben. Leider war die Heizung im Frachtraum ausgefallen - und der Mann erfror. Als die Verlobte den Koffer öffnete und ihren toten Freund darin sah, nahm auch sie sich das Leben.	3	51	42	80	Nachdem ein Mann seine Urlaubsgenehmigung erhalten hatte, packte er seinen Koffer. Seine Freundin riet ihm, den Koffer als Luftfracht aufzugeben. So konnte er ihn etwas schwerer packen und auch seine Gitarre mitnehmen. Im Flugzeug sitzend kam es ihm etwas kalt vor und da seine Jacke im Koffer war, bat er die Stewardess um eine Decke.	4	55	44	83
Die Anführerin einer Sekte hatte den Weltuntergang prophezeit. Die meisten Sektenanhänger, einschließlich ihrer Kinder, hatten am Vorabend Gift eingenommen, um das Ende nicht erleben zu müssen. Die Frau selbst wollte sich dem schrecklichen Ereignis stellen. Als sie am nächsten Morgen jedoch feststellten musste, dass sie sich getäuscht hatte, nahm auch sie sich das Leben.	4	54	47	94	Eine Frau leitete eine religiöse Glaubensgemeinschaft und hatte eine Menge für die gemeinsame Zukunft in ihrer Gemeinde geplant. Viele Gläubige besuchten zusammen mit ihren Kindern ihre Vorträge. Anschließend traf man sich und unterhielt sich bei Kaffee und Kuchen. Ihr Mann half ihr bei der Erstellung der Präsentationen und ihre Mutter backte den Kuchen.	4	53	43	89
Ein Militärpilot hatte bei einer Tiefflugübung in den Bergen das Seil einer vollbesetzten Gondel durchtrennt. Als er in den Abendnachrichten von dem Unglück hörte, wurde ihm klar, was am Nachmittag dieses leichte Vibrieren am Leitwerk verursacht haben musste. Daraufhin erhängte er sich.	3	42	37	74	Ein Pilot musste zur Bestätigung der Fluglizenz in regelmäßigen Abständen Flugübungen absolvieren. Nach seiner letzten Übung an einem der Trainingstage folgte noch ein routinemäßiger Gesundheitscheck. Dieser verlief ohne Befund und so konnte der Pilot seine Flugerlaubnis um weitere sechs Monate verlängern.	3	41	39	84

Appendix 1

In der Disko lernte ein junger Mann eine Frau kennen, mit der er noch in der selben Nacht Sex hatte. Als er am Morgen aufwachte, war sie bereits verschwunden. Auf dem Spiegel im Badezimmer hatte sie "Willkommen im Aids - Club " hinterlassen. Daraufhin machte er sein Testament.	4	48	38	68	Ein junger Mann ging abends in die Disko. Hier lernte er ein Mädchen kennen und sie tanzten eine Zeit lang miteinander. Später standen sie an der Bar und unterhielten sich, bis sie beide müde wurden. Sie verließen die Disko in den frühen Morgenstunden und fuhren nach Hause.	4	47	39	70
Ein Mann auf Argentinienrundreise rief sich ein Taxi. Plötzlich wurde er vom Fahrer überwältigt. Als er spät in der Nacht weit außerhalb der Stadt aufwachte, hatte er eine frische Narbe am Rücken. Wieder zu Hause bestätigte sich sein übler Verdacht: Man hatte ihm die linke Niere gestohlen.	4	47	42	69	Ein Mann war auf einer Argentinienrundreise. Da er tagsüber weit gelaufen war, um sich auch die Außenbezirke der Stadt anzuschauen, bestellte der sich am Abend ein Taxi zurück ins Stadtinnere. So kam es, dass er zum Abschluss des Tages noch ein paar Anekdoten vom Taxifahrer erzählt bekam.	3	47	42	78
Die Frau eines Messerwerfers kaufte sich kurz vor ihrem Auftritt am Abend neue Schuhe. Diese hatten höhere Absätze als die alten. Mit verbundenen Augen konnte ihr Mann, den sie überraschen wollte, den Unterschied nicht sehen und warf die Messer in gewohnter Höhe.	3	42	39	66	Eine Frau brauchte neue Schuhe. Sie besuchte verschiedene Schuhgeschäfte in der Stadt und probierte einige Modelle, die in Frage kamen, an. Nicht lange und sie hatte sich für ein Paar entschieden, ging zum Geldautomaten, hob das nötige Geld ab und bezahlte ihre neuen Schuhe.	3	44	39	61
Ein Fesselballon mit vier Mitfahrern an Bord war vom Kurs abgekommen und drohte an einem Berg zu zerschellen. Um Höhe zu machen, warfen die vier den gesamten Ballast über Bord. Es half nichts - einer musste springen. Sie losten. Später fand man am Fuß des Berges die Leiche des Mannes, der verloren hatte.	5	53	46	77	Eine Familie hatte einen Flug im Heißluftballon gebucht. Sie fuhren mit dem Auto zum vereinbarten Treffpunkt. Dort wurden sie vom Ballonführer belehrt und bestiegen gemeinsam den Ballon. Dann flogen sie durch die neblige Luft, die aber regenfrei blieb. Nach mehreren Stunden landeten sie wieder dort, wo sie gestartet waren.	5	49	44	86
Eine Frau lag tot inmitten eines Roggenfeldes. Hinter ihr lag ein Paket. Ansonsten gab es weit und breit keine Spuren. Wie sich herausstellte war die Frau eine leidenschaftliche Fallschirmspringerin und hatte Pech gehabt. Diesmal ließ sich ihr Schirm absolut nicht öffnen.	5	41	35	66	Ein Bauer bearbeitete sein Getreidefeld. Er hatte Roggen angebaut. Jetzt war es Hochsommer und die Ernte wurde eingefahren. Abwechselnd mit seinem Sohn fuhr er den Mähdrescher. So arbeiteten sie, bis das Feld leer und das Getreide gebunden auf dem gemeinsamen Hof war.	5	42	38	69
Ein Motorradfahrer war auf der Autobahn unterwegs zu seiner Familie und hatte einen Großteil der Strecke bereits zurückgelegt. Der vor dem Motorrad fahrende Lastwagen hatte einige Metallplatten geladen. Gerade als der Motorradfahrer zum Überholen ansetzte, löste sich eine Platte und trennte seinen Kopf vom Rumpf.	3	45	40	83	Ein Motorradfahrer plante eine Tagestour, die er möglichst abwechslungsreich gestalten wollte, weshalb er versuchte, eher Landstraßen zu nutzen. Er fuhr seine geplante Route, achtete manchmal auf die Gegend und erreichte am Abend sein Ziel. Hier kehrte er in eine Gastwirtschaft ein, wo er auch übernachten konnte.	3	46	40	75

Appendix 2

The opening sentences of Jane Austen's *Pride and Prejudice*.

It is a truth universally acknowledged, that a single man in possession of a good fortune, must be in want of a wife. However little known the feelings or views of such a man may be on his first entering a neighbourhood, this truth is so well fixed in the minds of the surrounding families, that he is considered the rightful property of some one or other of their daughters.

“My dear Mr. Bennet,” said his lady to him one day, “have you heard that Netherfield Park is let at last?”
Mr. Bennet replied that he had not.
“But it is,” returned she; “for Mrs. Long has just been here, and she told me all about it.”
Mr. Bennet made no answer.
“Do you not want to know who has taken it?” cried his wife impatiently.
“*You* want to tell me, and I have no objection to hearing it.”
This was invitation enough.
“Why, my dear, you must know, Mrs. Long says that Netherfield is taken by a young man of large fortune from the north of England; that he came down on Monday in a chaise and four to see the place, and was so much delighted with it, that he agreed with Mr. Morris immediately; that he is to take possession before Michaelmas, and some of his servants are to be in the house by the end of next week.”
“What is his name?”
“Bingley.”
“Is he married or single?”
“Oh! Single, my dear, to be sure! A single man of large fortune; four or five thousand a-year. What a fine thing for our girls!”
“How so? how can it affect them?"
“My dear Mr. Bennet,” replied his wife, “how can you be so tiresome! You must know that I am thinking of his marrying one of them.”
“Is that his design in settling here?"
“Design! Nonsense, how can you talk so! But it is very likely that he *may* fall in love with one of them, and therefore you must visit him as soon as he comes."
"I see no occasion for that. You and the girls may go, or you may send them by themselves, which perhaps will be still better, for as you are as handsome as any of them, Mr. Bingley may like you the best of the party."
"My dear, you flatter me. I certainly *have* had my share of beauty, but I do not pretend to be anything extraordinary now. When a woman has five grown-up daughters, she ought to give over thinking of her own beauty."
"In such cases, a woman has not often much beauty to think of." [...]

(http://www.fullbooks.com/Pride-and-Prejudice1.html, abgerufen am 23.03.2018)

Eidestattliche Erklärung

Die Studien dieser Dissertationsschrift wurden in marginal modifizierten Versionen in internationalen Fachzeitschriften veröffentlicht oder stehen derzeit unter Begutachtung:

Studie 1:

Altmann, U., Bohrn, I. C., Lubrich, O., Menninghaus, W., & Jacobs, A. M. (2012). The power of emotional valence—from cognitive to affective processes in reading. *Frontiers in Human Neuroscience*, *6*, 192. http://doi.org/10.3389/fnhum.2012.00192

Studie 2:

Altmann, U., Bohrn, I. C., Lubrich, O., Menninghaus, W., & Jacobs, A. M. (2014). Fact *vs* fiction—how paratextual information shapes our reading processes. *Social Cognitive and Affective Neuroscience*, *9*(1), 22–29. http://doi.org/10.1093/scan/nss098

Studie 3:

Altmann, U., Jacobs, A. M., Wilke, S., & Leder, H. (2017). *Beyond Beauty - Art as a canvas to social cognition, an fMRI study.* Article under review.

Hiermit erkläre ich, dass ich die vorliegende Arbeit selbständig und ohne unzulässige Hilfe verfasst habe.
Die angeführten Ko-Autoren können bestätigen, dass ich für die im Rahmen der Promotion durchgeführten Studien und die Erstellung der Fachartikel hauptverantwortlich war. Die Arbeit ist in keinem früheren Promotionsverfahren angenommen oder abgelehnt worden.

Berlin, den 30.07.2017

Ulrike Altmann