Marloes Mak, Roel M. Willems

Mental Simulation during Literary Reading

Abstract: Readers experience a number of sensations during reading. They do not – or do not only – process words and sentences in a detached, abstract manner. Instead they "perceive" what they read about. They see descriptions of scenery, feel what characters feel, and hear the sounds in a story. These sensations tend to be grouped under the umbrella terms "mental simulation" and "mental imagery." This chapter provides an overview of empirical research on the role of mental simulation during literary reading. Our chapter also discusses what mental simulation is and how it relates to mental imagery. Moreover, it explores how mental simulation plays a role in leading models of literary reading and investigates under what circumstances mental simulation occurs during literature reading. Finally, the effect of mental simulation on the literary reader's experience is discussed, and suggestions and unresolved issues in this field are formulated.

Introduction

Many readers imagine the events described in the stories they read. This process is often referred to as mental simulation. The term mental simulation has its origins in *simulation theory*, a theory in the philosophy of mind that describes how we understand the mental states of others (e. g., Goldman, 2006). According to Shanton and Goldman, in mental simulation "one mental event, state or process is the reexperience of another mental event, state, or process" (Shanton & Goldman, 2010, p. 528). "Reexperience" is key in this description. Simulation theorists posit that we understand other people by reenacting their thoughts or feelings.

Historically, simulation theory has been contrasted with *theory theory*, the position that we reason about others in a reflective, theory-based and non-simulative manner (see Stich & Nichols, 1993). A third position to consider is *interaction theory*, which posits that conscious reasoning is no prerequisite for our understanding of the mental states of others (in contrast to simulation theory and theory theory); instead, we instinctively understand others by (subconsciously) mapping non-verbal cues onto our own bodies. The debate between these three positions is beyond the scope of the current chapter (see Gallagher,

https://doi.org/10.1515/9783110645958-004

2015). Importantly, it might seem that "mental simulation," the core theme of this chapter, is directly linked to simulation theory. However, this does not need to be the case. The process of mental simulation during reading could be compatible with interaction theory (or a hybrid of interaction and simulation theory) equally well. From such a pluralistic standpoint it follows that the processes described in this chapter are compatible with any of the theories of social cognition (e. g., Andrews, 2008; Gallagher, 2015; Wiltshire et al., 2015).

Regardless, the increased interest in mental simulation in a wide variety of fields (see below) has led to stronger interest in how simulation theory can be incorporated into the philosophical and psychological theories of cognition. Fitting nicely into that trend, this chapter provides an overview of the role of "mental simulation" during literary reading. An intuitive starting point for this topic is the observation that during literary reading most readers do not only engage with a narrative in a detached, "theorizing" manner. Instead, they experience sensations ("pictures in the head"), report feelings for a character, or think along with a fictive character.

Mental Simulation vs. Mental Imagery

Mental simulation resonates with many distinct subfields of the social sciences and the humanities. Within psychology for instance, Barsalou (2008) has argued that conceptual understanding is grounded in the reenactment of previous experiences (sometimes called "embodiment," Barsalou, 2008; see Jacobs & Lüdtke, 2017, for a historical overview). Others (e. g., Kosslyn et al., 2001) have studied the conscious generation of images in the mind, a process called mental imagery. One prominent conceptual difficulty across studies lies in the distinction between "mental simulation" and "mental imagery," especially because the definition of these processes differs from one researcher to the next. Before discussing the theories and empirical data on mental simulation during literary reading, the contrast between simulation and imagery should be considered.

The terms mental simulation and mental imagery are sometimes used interchangeably. In this section we illustrate in what ways mental simulation and mental imagery are different. There are two areas of research that have approached mental simulation and mental imagery in different ways. We will now discuss each in turn.

In the first area of research, researchers have presented participants with words or sentences related to the senses and observed the effects on sensory perception. An example comes from Speed and Vigliocco (2014), who showed

that listening to sentences describing slow movement (e. g., The lion *ambled* to the balloon) led to slower eye movements than listening to sentences describing fast motion (e. g., The lion *dashed* to the balloon). In a similar vein, hearing sentences that imply a certain shape or orientation of an object primes visual recognition of that object – but *only* if that object is presented in the implied shape or orientation (Stanfield & Zwaan, 2001; Zwaan et al., 2002). Similarly, words implying a location on a vertical axis prime perception of objects appearing in this location (Estes et al. 2008; Ostarek & Vigliocco, 2017). Sentences implying a direction of movement prime subsequent movements if these movements are in the implied direction (Glenberg & Kaschak, 2002). Finally, visual and motor regions of the brain tend to be activated when reading action-related or sensory words (e. g., Hauk et al., 2004; see Willems & Casasanto, 2011, for an overview). The rationale behind these studies is to show that understanding language related to actions or to the senses leads to sensorimotor activations in the brain. This process is called mental simulation.

In the second area of research, researchers have looked into the neurocognitive basis of the *deliberate* ("conscious") creation of mental images, aptly called "mental imagery." An early driving force for this work was the so-called "imagery debate" (Kosslyn, 1994; Pylyshyn, 2003). An important issue in that debate was whether primary sensory and motor regions are involved in imagery as they are during actual perception and motor actions. In this spirit, it was found that motor imagery elicited activation in the same brain areas as motor preparation, motor control and motor execution (De Lange et al., 2008; Jeannerod, 1994, 2001; Lotze & Halsband, 2006; Parsons et al., 1995). Similarly, for perceptual imagery, there is overlap between brain areas involved in perceptual imagery and real perception (Dijkstra et al., 2017; Kosslyn et al., 2001).

A striking difference between mental simulation and mental imagery is the speed at which each occurs. While reading language, mental simulation can be very fast, feeling effortless. In contrast, during deliberate mental imagery, image-generation takes more time (seconds or more) and is subjectively effortful. A basic similarity between the sensorimotor processes elicited by the fast, seemingly effortless act of word or sentence reading and the slow, effortful image-generation of mental imagery is that in both cases sensorimotor systems are recruited.

It may seem that mental simulation and mental imagery differ in degree: perhaps what happens during reading is just an "impoverished" or scaled down version of the image-generation that is executed during full-fledged mental imagery. However, there is reason to believe that this is not the case. It has been argued that the type of mental simulation elicited during language comprehension is *qualitatively* different from imagery. Troscianko (2013) makes this point

on conceptual grounds. She argues that mental simulation during reading should not be seen as a mental picture (or image) that a reader creates while reading, but rather as something coming from motoric or sensory memories. That is, memories of previous experiences with actions and objects in the actual world determine how language is understood without the need to form vivid mental pictures (as is the case in conscious mental imagery). Willems and colleagues (2010) provided empirical support for such a qualitatively different neural basis. In the present chapter, the simulative processes occurring during reading or listening to language will be referred to as "mental simulation," and the term "mental imagery" will be reserved for situations in which participants engage in deliberate and conscious mental imagery.

Kinds of Mental Simulation During Literary Reading

Next, we will consider four theories of how mental simulation plays a role specifically during literary reading.

Varieties of Mental Imagery During Literary Reading

In an important theoretical contribution, Kuzmičová (2014) has suggested that mental imagery[1] during literary reading is not one of a kind, but can be experienced at a few different levels. Furthermore, which of the different forms of mental imagery is experienced at a given time during reading is dependent on both text characteristics and reader characteristics.

Kuzmičová calls the most basic level of mental imagery *rehearsal-imagery*. Readers experiencing this kind of imagery perceive the words in the stories they read as if they are reading them aloud (without actually articulating the words). This kind of imagery is most often triggered by longer, syntactically complex sentences, or by sentences that contain certain stylistic elements such as rhythm or alliteration (which need to be articulated to be fully appreciated).

1 Note that although Kuzmičová uses the term imagery, she defines this as the non-conscious, automatic process we have called simulation. We will also use the word imagery when discussing Kuzmičová's theories, but it is important to keep in mind that imagery as defined by Kuzmičová is by no means the same as imagery as defined by Kosslyn, Jeannerod, Parsons and others (see above).

The second level, *speech-imagery*, differs from rehearsal-imagery in that readers do not hear *their own* voices in their mind while reading, but rather the voices of *characters* in the story, as if they are witnessing their conversations. This is most often triggered by dialogues in stories and not as much by stylistic elements. Together, rehearsal-imagery and speech-imagery form the verbal domain of the mental imagery continuum.

Beyond the verbal domain, there is the referential domain, which is most closely linked to embodied cognition theories in psychology. Again, according to Kuzmičová (2014) there are two levels of imagery that comprise the referential domain. The first is called *description-imagery*, where readers form (mostly, but not only, visual) pictures of objects or situations described in a story, specifically from an observer's perspective. Description-imagery is often triggered by elaborate descriptions of how (inanimate) objects in stories look, sound, or feel. This is unlike *enactment-imagery* (according to Kuzmičová the highest level of mental imagery) in which readers form mental pictures from the perspective of a character in the story, almost as if they are acting out the situations in the story. Enactment-imagery is triggered by concrete and imageable descriptions of the sensorimotor experiences of characters.

It could be argued that the difference between description-imagery and enactment-imagery reflects differences in viewpoint or stance (comparable to the relationship between viewpoint in narratives and identification with characters; Van Krieken et al., 2017). Description-imagery is experienced from a third person stance, whereas enactment-imagery is experienced from a first person stance. Consequently, the experience of description- or enactment-imagery could be dependent on text characteristics or contextual information encouraging a first versus third person interpretation.

It is important to underscore that Kuzmičová (2014) acknowledges that readers' experiences can also resemble an in-between form between two levels of mental imagery. Additionally, she stresses that it is not the case that a given reader can only experience one level of mental simulation. During reading, readers constantly switch between imagery levels, as a result of a continuous interplay between the text characteristics of the passages read and internal reader characteristics. Kuzmičová hypothesizes that the transition between different levels will be smooth and (almost) non-conscious within the verbal and referential domains, whereas it will be conscious when readers switch between the domains.

Neurocognitive Poetics Model

A more general theory of the cognitive processes going on during literary reading is Jacobs' (2015) *Neurocognitive Poetics Model*. Although this model is not specific to mental simulation during reading, as is Kuzmičová's theory, the Neurocognitive Poetics Model does provide insight into the circumstances that make the occurrence of mental simulation during literary reading most likely. This theory is built on the premise that reading stories is more than just reading words on a page: if stories were processed as mere "cold" lists of words and sentences, they would probably not elicit strong emotions (Jacobs, 2015). Because stories challenge readers to create mental pictures during reading, readers can become emotionally involved when reading stories, but not when reading lists of words. In the paper introducing his Neurocognitive Poetics Model (NCPM), Jacobs (2015) argues that simulation is evoked by backgrounded elements in stories (as opposed to foregrounded elements).

At the heart of the NCPM lies the distinction between two routes of literary reading, a fast route and a slow route. The fast route is provoked by backgrounded elements in stories, such as familiar words and phrases, high frequency words, and highly imageable words. This route evokes fluent reading through implicit processing and fiction feelings and is hypothesized to be related to immersive processes during reading. Fluent reading is considered to be automatic and subconscious, just as mental simulation during reading is considered to be automatic and subconscious. Additionally, the hypothesized link between fluent reading and immersive processes is reminiscent of the link between mental simulation and immersive processes (elaborated in the section on offline studies of simulation). Therefore, it seems probable that mental simulation plays an important role in this mode of reading.

The slow route is provoked by foregrounded elements in stories: for example, metaphors, abstract and defamiliarizing language, rhyme and rhetorical devices. Foregrounded elements are hypothesized to evoke dysfluent reading through explicit processing and aesthetic feeling (Jacobs calls this the aesthetic trajectory). The outcome of dysfluent reading is the aesthetic appreciation of literature and poetry. Interestingly, this route is triggered by stylistic elements in stories, similar to Kuzmičová's (2014) rehearsal-imagery (see above). Although, in general, mental simulation seems to play a role in the fast route of reading, perhaps some forms of simulation (i. e., perceiving the stories as if one were reading them aloud) are actually more involved in the slow route of reading.

Interestingly, Kuiken and Douglas (2017, 2018) distinguish between simulation of content related to peri-personal space versus content related to extra-

personal space. They hypothesize that processing (or simulating) objects in peri-personal space (such as sensorimotor imagery) is part of the slow, foregrounded route. In contrast, content related to extra-personal space (such as visuospatial imagery) is hypothesized to be part of the backgrounded, fast route of literary reading. As Jacobs (2015) does not go into detail about the involvement of different forms of mental simulation in the two routes of the NCPM, only future research will be able to determine whether different forms of mental simulation indeed play roles in different routes of the NCPM, and, if so, which levels of simulation play roles in which routes of literary processing.

Simulating Feelings

Apart from perceptually simulating objects and situations or motorically simulating actions described in stories, it is also possible to simulate story characters' feelings. Simulating feelings elicits those feelings in readers. According to Miall and Kuiken (2002) this can happen on four levels that differ in the "depth" of these feelings. Miall and Kuiken called the first, most basic, level *evaluative feelings*. This level comprises feelings like enjoyment of a story or reading pleasure – feelings that can drive a reader to continue reading a story but do not result in a deep involvement in the story.

The second level identified by Miall and Kuiken is the level of *narrative feelings*. Narrative feelings include empathy for and sympathy with the characters in the story or feelings that are a response to specific events in the story. These feelings require a reader to step into the shoes of the story character and (to some extent) simulate the story world and feelings of the characters. This level of feelings may be elicited by description-imagery as defined by Kuzmičová (2014).

The third level of feelings elicited by stories is called *aesthetic feelings*. Aesthetic feelings are not elicited by story events but by stylistic elements in the stories. Certain metaphors, choice of words, or sentence constructions can fascinate or intrigue readers and capture their attention. In terms of the levels of mental imagery defined by Kuzmičová (2014), aesthetic feelings may be linked to the verbal domain (mainly rehearsal-imagery), which Kuzmičová claims is associated with stylistic elements of stories, such as prosody and rhythm. In terms of the NCPM (Jacobs, 2015), this level of feelings probably results from processing via the slow route of the NCPM.

The fourth and highest level of feelings that can be elicited by literary fiction is called *self-modifying feelings* (Miall & Kuiken, 2002). At this level, a combination of perspective taking and stylistic elements elicits a deep identification

with the story and story characters. Identification at the fourth level stands out from the other levels in that it is grounded in memories of feelings readers have experienced in their own lives. This is closely related to the process of "reexperiencing" proposed by Goldman and Barsalou (described at the beginning of this chapter). To elaborate, the power of fiction to elicit self-modifying feelings results from readers reexperiencing their past feelings, possibly through mental simulation (i. e., most probably through simulation at the level of enactment-imagery).

As self-modifying feelings are in large part grounded in the process of perspective taking, it is important to highlight that there are different types of perspective taking. Healey and Grossman (2018) distinguish cognitive and affective perspective taking. They show that the most remarkable neural difference between the two types of perspective taking is the relative involvement of emotion areas in affective perspective taking and the relative involvement of executive processes (e. g., working memory, switching, inhibitory control) in cognitive perspective taking. Consequently, it is possible that affective perspective taking can take place subconsciously, but that seems unlikely for cognitive perspective taking. Of course, it is difficult to say whether readers will engage in affective or cognitive perspective taking when reaching the level of self-modifying feelings (and preferences for types of perspective taking may also differ largely between individuals). However, whether a reader will reach this level of feelings may depend in part on the type of perspective taking in which this reader engages. Affective perspective taking may lead a reader to self-modifying feelings to some extent, perhaps even subconsciously through mental simulation. However, it is probable that the reader will experience these self-modifying feelings more easily through conscious processing (i. e., consciously linking events in the story to real-life experiences).

Simulation of Social Worlds

Apart from triggering the simulation of perception, actions, and feelings, fiction can also help readers to simulate social worlds and social situations (Oatley, 2016). Oatley reviews evidence that people become more socially skilled as a result of interacting with fiction. Fiction is therefore seen as a means to "train" our theory of mind. To reach this effect of fiction reading, readers must simulate the thoughts and motivations of characters, rather than the physical events and surroundings described in stories or the feelings of the story characters. According to Oatley, exercising this kind of simulation in the fiction world helps people practice empathizing with and understanding people in the real world. The

simulation of social worlds is seen as an additional way of simulating stories apart from perceptual and motor simulation, but they are not unrelated: vivid perceptual and motor simulation in highly transporting stories increases the ease of the simulation of social worlds (Oatley, 2016).

Empirical Evidence for the Role of Mental Simulation During Literary Reading

In the previous sections, several theories about mental simulation during literary reading have been considered. The next section will give a bird's eye view of empirical findings regarding mental simulation during literary reading. Note that this is not a full review of available evidence for mental simulation, but the diversity of approaches and findings in this field will be highlighted.

The role of mental simulation during literary reading has been studied from different angles. A few researchers have studied mental simulation directly, whereas others have studied it as a byproduct of other processes involved in literary reading (e. g., absorption, transportation, aesthetic processes). One line of research has studied mental simulation during reading "after the fact," for instance via questionnaires. These are referred to as offline studies. Another line of research has collected data *during* reading, for instance using fMRI or eye tracking. These studies are referred to as online studies in the remainder of the chapter.

Offline Studies of Mental Simulation

In many offline studies of mental simulation, the role of mental simulation in theories of *absorption* during literary reading is investigated. Absorption relates to the ability of literature to grasp readers' attention and take them into a story world. This process has been identified in different ways, with some of the definitions of this process emphasizing the role of mental imagery. Both Transportation (Green & Brock, 2000) and Story World Absorption (Kuijpers et al., 2014; see also Kuiken & Douglas, 2017) include mental imagery and embodied processes as important parts of these experiences. An often used paradigm in the study of mental simulation and absorption during literary reading is the use of imagery instructions and training to promote the use of imagery. In one study, imagery-generation training before reading (i. e., instructing the participant to

imagine viewing and handling a lemon; Johnson et al., 2013) resulted in a more transported reading experience when subsequently reading a story than did focusing on the semantic meaning of the words in sentences or reading for leisure. The same study found that imagery-generation training led to higher affective empathy and more prosocial behavior after reading, measured as the number of people in each experimental group who voluntarily completed an extra survey after the experiment. Importantly, the imagery and semantic instructions were given in the training phase of the experiment (before an additional task that did not involve reading stories) and were not repeated right before reading the story. Participants were thus not explicitly instructed to use mental imagery while reading the story or to focus on the semantic elements in the story. Any effect of the imagery training in the training phase had to generalize to a different task (i. e., story reading) to produce the results found in this experiment (and, importantly, may have been implicit or subconscious, more like mental simulation than imagery). These results suggest that imagery (or at least simulation) influences the experience of transportation, affective empathy, and prosocial behavior during reading.

However, the influence of mental imagery (or mental imagery training) on the outcomes of literary reading is not always as pronounced as in the study by Johnson and colleagues (2013). On the contrary, multiple studies have failed to find an association between mental imagery (as promoted by reading instructions) and reading outcomes, such as transportation, absorption, and appreciation (e. g., Green, 2004; Green & Brock, 2000; Mak et al., 2020). This failure to find a direct link between (explicit) mental imagery and reading outcomes suggests that the conscious process of mental imagery may not define reading experiences, as opposed to subconscious or implicit mental simulation (as in the study by Johnson et al., 2013). This may confirm that mental simulation during literary reading is an implicit, unconscious process (as suggested by Kuzmičová, 2014) and that people cannot easily and voluntarily switch it on and off in response to a reading instruction – even though it possibly can be trained, as in Johnson et al. (2013). However, this lack of results in instruction studies could of course also mean that mental simulation does not play a substantial role during literary reading. Overall, it seems that explicit instruction studies cannot give definitive proof of the effects of mental simulation during reading.

Offline research into mental simulation during reading is often dependent on self-report measures to determine its strength, requiring conscious reports of mental simulation. Importantly, subconscious mental simulation during literary reading *can* become conscious (cf. Kuzmičová, 2014). For example, Fialho (2018) interviewed readers using specific questions to help them tap into their reading experiences (thereby making them conscious). These interviews re-

vealed that mental simulation can be auditory (as if the reader hears the voices of the characters; cf. Kuzmičová's speech-imagery); visual (as if the reader sees the characters or objects in the story, cf. Kuzmičová's description-imagery); or tactile and embodied (the reader simulates the sensorimotor experiences of characters; cf. Kuzmičová's enactment-imagery). However, caution is required when interpreting subjective reports of subconscious mental simulation. Evidence from embodied cognition research suggests that the process of bringing implicit simulations to awareness is quite error-prone (Connell & Lynott, 2016). In a series of experiments these authors show that a lot of information is lost when people consciously report on their subconscious mental simulations, especially if these simulations are complex and multimodal (Connell & Lynott, 2016). Therefore, it is important to keep in mind that asking readers to report on the content of their simulations will not result in a complete picture of their simulations.

Apart from motor and sensory simulation, simulation of feelings and social worlds during literary reading has also received attention in empirical studies. In one study, Mar and colleagues (Mar et al., 2006) found that exposure to fiction was associated with interpersonal sensitivity, whereas exposure to non-fiction was not. After controlling for fiction exposure, the correlation between non-fiction exposure and interpersonal sensitivity was even negative. An explanation for these findings is that reading fiction is a way to simulate social situations and, therefore, a way to train interpersonal sensitivity. Non-fiction usually does not invite simulation of social situations, and therefore exposure to non-fiction would not be correlated with interpersonal sensitivity. In a later online survey, these findings were replicated in a much larger cohort of participants (N = 328; Fong et al., 2013). Of course, these studies are correlational, and claims cannot be made about causality.

Online Studies of Mental Simulation

Several attempts have been made to measure mental simulation using online measures (measuring mental simulation *during* reading), as opposed to offline questionnaire or other self-report measures (measuring mental simulation *after* reading). Measurement techniques that have been used include electrodermal activity, eye tracking, and neuroimaging (fMRI).

One of the experiments tapping into online effects of simulation is the experiment reported by Hartung and colleagues (2016). The authors asked participants to read stories in first and third person perspective, while measuring their electrodermal activity (EDA). On a self-report measure, participants re-

ported higher mental imagery after reading first person stories than after reading third person stories. Comparing this to participants' electrodermal activity during reading, stories in first person perspective were associated with fewer peaks in the EDA. As EDA is associated with arousal, but also with increased processing effort, the authors suggested that this had to do with the processing of first person stories being easier and more natural than the processing of third person stories. This may indicate that mentally imaging the characters in a story is a preferred way of processing stories and that this is easiest to achieve if stories are written in first person perspective, the same perspective people use to talk about themselves and their own thoughts and actions (again implying that mental imagery or simulation during reading is based on reexperiencing our own life experiences). These findings could also be a confirmation that there is indeed a difference between enactment-imagery (which may be more likely in the case of first person processing) and description imagery (which may be more likely in the case of third person processing).

A second experiment tapping into online effects of simulation used eye tracking to study mental simulation during literary reading (Mak & Willems, 2019). In this study, different kinds of simulation (i. e., action simulation, perceptual simulation and mentalizing) were distinguished, using descriptions in stories that were hypothesized to elicit these kinds of simulation (note that action descriptions were not *only* verbs, and perceptual descriptions were not *only* nouns – these descriptions included relevant context). It was found that, based on eye movements during reading, it was indeed possible to distinguish between these kinds of simulation (i. e., action simulation was associated with faster reading, while perceptual simulation and mentalizing were associated with slower reading). It is possible to interpret these findings within Kuzmičová's (2014) framework. Descriptions of actions are likely to result in a first person interpretation and consequently enactment-imagery, whereas descriptions of percepts may result more often in a third person interpretation and description-imagery (see also Hartung et al., 2016; Van Krieken et al., 2017). Differences between first person and third person processing (and simulation) may explain differences in reading speed during action simulation and perceptual simulation. Also, mentalizing may be comparable to the simulation of feelings (Miall & Kuiken, 2002) and the simulation of social worlds (Oatley, 2016). The results from the study by Mak and Willems (2019) confirm that these different forms of simulation can indeed be dissociated and may be rooted in distinct (neural or cognitive) processes.

Turning now to neuroimaging evidence, some studies suggest a role for mental simulation during reading in research into situation model building (Zwaan & Radvansky, 1998) and event segmentation theory (Kurby & Zacks,

2008). When people read stories, they build so-called situation models of the (events in the) stories they read. When more information becomes available as readers progress through the stories, this new information is added to their situation model, or it may prompt them to construct an entirely new situation model if the new information is too different from the information already in the existing situation model (which is based on earlier portions of the story). When important aspects of situation models have to be updated (or new situation models have to be created), readers experience this as an event boundary in the text. Readers are able to reliably and effortlessly segment stories based on event boundaries, and neuroimaging studies have found increased brain activation when people are encountering such event boundaries (e. g., Speer et al., 2009; Speer et al., 2007; Yarkoni et al., 2008). Additionally, brain activity during reading has been found to be modality-specific: when people are reading about auditory events, this elicits activation in auditory processing areas, whereas reading about motoric events elicits activation in motor areas of the brain (Kurby & Zacks, 2013; Speer et al., 2009).

Similarly, Hsu et al. (2015a) found that emotional passages from Harry Potter novels elicit activity in emotion processing areas. Neutral passages, on the other hand, elicit activity in areas of the Default Mode Network. The Default Mode Network has been found to be involved in the processing of temporal coherence in narratives as they unfold (Simony et al., 2016). In another analysis of the same data, Hsu et al. (2015b) concluded that the activity in emotion processing areas could not solely be the result of reading emotionally laden *words* in these passages. The authors gave two reasons for concluding this. First, behaviorally, they found that subjective arousal and valence ratings of the passages could not entirely be explained by the average arousal values and valence of the words comprising these sentences. Second, neurally, these average arousal values and valences of the words were associated with increased activity in emotion processing areas, but increased activity in these areas was also associated with arousal and valence *span* (a measure of the spread of arousal values and valences of words in a passage – calculated as the difference between the lowest and the highest arousal values and valences of these words). Hsu and colleagues (2015b) concluded from this that the whole is greater than the sum of its parts when readers encounter emotional passages in stories. How stories are experienced is not just the result of reading a collection of words (cf. Jacobs, 2015).

Individual Differences in Mental Simulation

Although the preceding results show that stories elicit modality-specific brain activation, this does not occur similarly for all readers. That is, the effect of a story does not lie solely in the words and text characteristics of which the story is comprised. Instead, the effect of a story is also dependent on individual difference variables, such as personality and life experiences (cf. Jacobs, 2015). This is compatible with the idea that mental simulation is based on the reexperience of personal life events and experiences (Barsalou, 2008; Shanton & Goldman, 2010). As every person has a unique combination of personality and life experiences, every person will also create a unique mental picture of a story, and therefore this story will be uniquely experienced by each reader (see also van Laer et al., 2014).

Kuzmičová already predicted that every reader will go through the different levels of mental simulation styles during reading in a unique way (depending on an interaction between text characteristics and reader differences, see Kuzmičová, 2014). A few experimental studies suggest that this is indeed the case.

First, the overall association of action simulation with decreased reading times (faster reading) and perceptual simulation and mentalizing with increased reading times (slower reading) found by Mak and Willems (2019) varied widely between participants. The most evident variation was found in the case of mentalizing, which on average was associated with slower reading, but was associated with faster reading among some participants. Further analysis of these individual differences revealed that some people experienced a stronger association between simulation and reading times (across all kinds of simulation) than others. This meant that these readers were more prone to simulation (in general), independent of the kind of simulation. In other words, it seems that when readers simulate more, they do so across simulation types. Additionally, these individual differences in the associations between simulation and reading times were related to individual differences in reading outcomes such as absorption and appreciation. This hints at an association between mental simulation and these reading outcomes and it might mean that absorption and appreciation are (at least to a certain extent) shaped by mental simulation.

An fMRI study by Hartung et al. (2017) also showed that people differ in their preferred type (or level) of simulation during the reading of stories. The authors distinguished three groups of readers based on an offline self-report question. When subsequently looking at the brain activation patterns of participants in these groups during reading, they found marked differences. The first group showed activation in a region in the right frontolateral pole and were

called “enactors” by the authors; these people may have preferred enactment-imagery (Kuzmičová, 2014). The second group showed activation in a network including the right inferior frontal gyrus, left postcentral gyrus, left supramarginal gyrus, and left and right posterior superior and middle temporal gyri. Called “observers” by the authors, these people may have preferred description-imagery (Kuzmičová, 2014). The third group was called “hypersimulators”; these people showed activation in both networks. In terms of Kuzmičová’s model (2014), this group may not have a default or preferred level of simulation, but instead switch between different levels of simulation during reading.

This distinction between subgroups of readers is reminiscent of the subgroups distinguished in a behavioral study by Kozhevnikov et al. (2005). They classified participants as “visualizers” or “verbalizers” according to the Visualizer-Verbalizer Cognitive Style Questionnaire and found that verbalizers scored at intermediate levels on mental imagery tasks, whereas visualizers scored high on either spatial imagery or object imagery tasks. This implies that people can be visualizers (prone to mental imagery) or verbalizers, but, interestingly, there also appeared to be individual differences within the group of visualizers. Apparently, people can be skilled in particular forms of imagery (i. e., spatial imagery or object imagery). These findings could be an indication that some people prefer the levels of imagery within the verbal domain in Kuzmičová’s model (and are more prone to the slow route in the NCPM, which is mainly associated with verbalizing and foregrounding), whereas others prefer the levels of imagery in the referential domain (and the fast route in the NCPM, which is associated with mental simulation, absorption, and backgrounding).

Another fMRI study by Nijhof and Willems (2015) looked at brain activity associated with listening to action descriptions and descriptions of mental events within literary stories. The authors found that listening to action descriptions was associated with activity in areas involved in action execution, whereas listening to descriptions of mental events was associated with activity in areas involved in mentalizing. Importantly, they found interesting individual differences, indicating that some participants were particularly responsive to action descriptions but not to descriptions of mental events, whereas others were responsive to descriptions of mental events but not to action descriptions. Together, these studies imply that there are differences between readers in their preferred mode or level of simulation.

Conclusion and Suggestions for Further Research

This chapter has reviewed theories and empirical evidence regarding the role of mental simulation during reading. Perhaps the most important question is whether mental simulation during reading is an important topic to study. Does it play a significant role in literary reading, and does it influence reading experiences to an important degree? From the work of (among others) Zacks, Speer, Hsu, Jacobs, Hartung, and Willems, it can be concluded that mental simulation at least plays some role during literary reading, even though it is still unclear how big that role is compared to other processes involved in literary reading (e. g., foregrounding, deviation, aesthetics). However, it is undeniable that mental simulation does occur during literary reading and plays a role in determining subjective reading experiences, which is why this subject will hopefully receive much more theoretical and empirical attention in coming years.

As demonstrated, the phenomenon of mental simulation intrigues researchers from different disciplines. Although this is laudable, it also entails some complications: different disciplines use the terminology around mental simulation quite differently. Especially the terms *mental simulation* and *mental imagery* have been used interchangeably, and they appear to be defined slightly differently in different disciplines. Consequently, it is time for some conceptual clarification. We propose that the term *mental imagery* only be used to describe deliberate, conscious imagery and the term *mental simulation* only be used to describe automatic, subconscious imagery. There is reason to believe that these are indeed distinctive processes that are both cognitively and neurally qualitatively different. Although it is technically possible for readers to exercise deliberate, conscious mental imagery during reading, this process would be too effortful to maintain during natural reading. Unfortunately, the distinction between mental imagery and mental simulation has not yet permeated the empirical literature, although it has been mentioned in the theoretical literature. When empirically studying imagery processes during reading, it would be fruitful to focus predominantly on mental simulation.

Also, many of the studies described in this chapter (especially the offline studies) have not investigated mental simulation directly, but instead examined related concepts such as identification or absorption. Most of these studies define mental simulation merely as the creation of vivid (visual) mental images during reading (with the exception of Kuiken & Douglas, 2017). It remains to be seen whether the imagery involved in these experiences is the conscious, deliberate kind or the non-conscious non-deliberate mental simulation described by, among others, Kuzmičová. To stimulate such direct studies of mental simula-

tion, there is a need for a clearer definition of this phenomenon and recognition of its multifaceted nature (i. e., it does not only involve visual simulation). The existing questionnaires tapping into absorption and transportation do not reflect this multidimensional conception of mental imagery. Because of this, a warning may be in order for researchers interested in mental imagery and simulation: although these questionnaires are useful and informative with regard to transportation and absorption, they do not measure the multidimensionality of simulation as it occurs during literary reading. Therefore, the imagery subscales of absorption or transportation questionnaires are best used in combination with other measures of simulation.

Furthermore, the lack of direct empirical studies of mental simulation during literary reading may be due to the lack of readily available and affordable methods to measure this process; such methods need to be developed in future research, in coordination with a more precise definition of mental simulation. The model provided by Kuzmičová (2014) seems to be a guide for developing these methods and definitions.

One promising methodological advance comes from the recent development of the Imaginal Vividness scale (IVS; Fialho, personal communication). This questionnaire is partly based on the Literary Response Questionnaire (Miall & Kuiken, 1995) and partly on a series of in-depth interviews with readers. This questionnaire is a more elaborate measure of imagery compared to imagery subscales of the existing absorption and transportation questionnaires. It focuses on aspects of mental simulation in multiple sensory modalities. In this way, the IVS allows researchers to capture the quality of experienced imagery in more detail than the imagery subscales of absorption or transportation scales (although perhaps still not in as much detail as warranted by the model of Kuzmičová). Of course, this questionnaire is still in development, and there is no documentation of its psychometric properties at this time. However, it is a promising first step towards more comprehensive but also readily available and affordable methods for measuring mental simulation during reading.

When studying mental simulation, it is important to acknowledge that mental simulation can affect different readers in different ways. It is crucial to allow for individual differences when designing empirical studies. Averaging results over groups may mask effects that would be visible when taking individual differences into account. To have sufficient statistical power to find such effects, it is important to use large sample sizes and measure individual reading experiences.

Unfortunately, the place of mental simulation in current reading theories has not received enough attention. For example, it is unclear how different forms of mental simulation may influence the different routes suggested by the

NCPM. The same challenge might affect studies of foregrounding theories. How are foregrounding and mental simulation related? Are they mutually exclusive, or could they additively determine reading experiences such as absorption or aesthetic appreciation? Another possibility is that there are cognitive processes that play a defining role in mental simulation. For example, what role do personal episodic memories and experiences play in determining mental simulation? Theoretically, mental simulation is a result of the reexperience of these memories and experiences, but whether and how this is so deserves more attention in empirical research.

Funding Statement

This work was supported by the Netherlands Organization for Scientific Research (NWO) [Grant Number Vidi-276-89-007].

References

Andrews, K. (2008). It's in your nature: a pluralistic folk psychology. *Synthese*, *165*, 13–29. https://doi.org/10.1007/s11229-007-9230-5

Barsalou, L. W. (2008). Grounded cognition. *Annual Review of Psychology*, *59*(1), 617–645. https://doi.org/10.1146/annurev.psych.59.103006.093639

Connell, L., & Lynott, D. (2016). Do we know what we're simulating? Information loss on transferring unconscious perceptual simulation to conscious imagery. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *42*(8), 1218–1232. https://doi.org/10.1037/xlm0000245

De Lange, F. P., Roelofs, K., & Toni, I. (2008). Motor imagery: A window into the mechanisms and alterations of the motor system. *Cortex*, *44*(5), 494–506. https://doi.org/10.1016/j.cortex.2007.09.002

Dijkstra, N., Bosch, S. E., & Van Gerven, M. A. J. (2017). Vividness of visual imagery depends on the neural overlap with perception in visual areas. *The Journal of Neuroscience*, *37*(5), 1367–1373. https://doi.org/10.1523/JNEUROSCI.3022-16.2016

Estes, Z., Verges, M., & Barsalou, L. W. (2008). Head up, foot down: Object words orient attention to the objects' typical location. *Psychological Science*, *19*(2), 93–97. https://doi.org/10.1111/j.1467-9280.2008.02051.x

Fialho, O. (n. d.). Transformative Reading Scale (Manuscript in preparation).

Fialho, O. (2018). Deepening readers' perceptions of self and others. *IGEL Conference presentation, July 2018, University of Stavanger, Norway*.

Fong, K., Mullin, J. B., & Mar, R. A. (2013). What you read matters: The role of fiction genre in predicting interpersonal sensitivity. *Psychology of Aesthetics, Creativity, and the Arts*, *7*(4), 370–376. https://doi.org/10.1037/a0034084

Gallagher, S. (2015). The new hybrids: Continuing debates on social perception. *Consciousness and Cognition*, *36*, 452–465. https://doi.org/10.1016/j.concog.2015.04.002

Glenberg, A. M., & Kaschak, M. P. (2002). Grounding language in action. *Psychonomic Bulletin & Review*, *9*(3), 558–565. https://doi.org/10.3758/BF03196313

Goldman, A. I. (2006). *Simulating minds: The philosophy, psychology, and neuroscience of mindreading*. Oxford UP. https://doi.org/10.1093/0195138929.001.0001

Green, M. C. (2004). Transportation into narrative worlds: The role of prior knowledge and perceived realism. *Discourse Processes*, *38*(2), 247–266. https://doi.org/10.1207/s15326950dp3802_5

Green, M. C., & Brock, T. C. (2000). The role of transportation in the persuasiveness of public narratives. *Journal of Personality and Social Psychology*, *79*(5), 701–721. https://doi.org/10.1037/0022-3514.79.5.701

Hartung, F., Burke, M., Hagoort, P., & Willems, R. M. (2016). Taking perspective: Personal pronouns affect experiential aspects of literary reading. *PLoS ONE*, *11*(6), e0157285. https://doi.org/10.1371/journal.pone.0154732

Hartung, F., Hagoort, P., & Willems, R. M. (2017). Readers select a comprehension mode independent of pronoun: Evidence from fMRI during narrative comprehension. *Brain and Language*, *170*, 29–38. https://doi.org/10.1016/j.bandl.2017.03.007

Hauk, O., Johnsrude, I., & Pulvermüller, F. (2004). Somatotopic representation of action words in human motor and premotor cortex. *Neuron*, *41*, 301–307. https://doi.org/10.1016/S0896-6273(03)00838-9

Healey, M. L., & Grossman, M. (2018). Cognitive and affective perspective-taking: Evidence for shared and dissociable anatomical substrates. *Frontiers in Neurology*, *9*, 1–8. https://doi.org/10.3389/fneur.2018.00491

Hsu, C.-T., Jacobs, A. M., & Conrad, M. (2015a). Can Harry Potter still put a spell on us in a second language? An fMRI study on reading emotion-laden literature in late bilinguals. *Cortex, 63*, 282–295. https://doi.org/10.1016/j.cortex.2014.09.002

Hsu, C.-T., Jacobs, A. M., Citron, F. M. M., & Conrad, M. (2015). The emotion potential of words and passages in reading Harry Potter – An fMRI study. *Brain and Language, 142*, 96–114. https://doi.org/10.1016/j.bandl.2015.01.011

Jacobs, A. M. (2015). Neurocognitive poetics: Methods and models for investigating the neuronal and cognitive-affective bases of literature reception. *Frontiers in Human Neuroscience*, *9*, 186. https://doi.org/10.3389/fnhum.2015.00186

Jacobs, A. M., & Lüdtke, J. (2017). Immersion into narrative and poetic worlds: A neurocognitive poetics perspective. In F. Hakemulder, M. M. Kuijpers, E. S. Tan, K. Bálint, & M. M. Doicaru (Eds.), *Narrative absorption* (pp. 69–96). Benjamins. https://doi.org/10.1075/lal.27.05jac

Jeannerod, M. (1994). The representing brain: Neural correlates of motor intention and imagery. *Behavioral and Brain Sciences*, *17*(2), 187–245. https://doi.org/10.1017/S0140525X00034026

Jeannerod, M. (2001). Neural simulation of action: A unifying mechanism for motor cognition. *NeuroImage*, *14*, S103-S109. https://doi.org/10.1006/nimg.2001.0832

Johnson, D. R., Cushman, G. K., Borden, L. A., & McCune, M. S. (2013). Potentiating empathic growth: Generating imagery while reading fiction increases empathy and prosocial behavior. *Psychology of Aesthetics, Creativity, and the Arts*, *7*(3), 306–312. https://doi.org/10.1037/a0033261

Kosslyn, S. M. (1994). *Image and brain: The resolution of the imagery debate*. MIT Press.

Kosslyn, S. M., Ganis, G., & Thompson, W. L. (2001). Neural foundations of imagery. *Nature Reviews Neuroscience*, *2*, 635–642. https://doi.org/10.1038/35090055

Kozhevnikov, M., Kosslyn, S., & Shephard, J. (2005). Spatial versus object visualizers: A new characterization of visual cognitive style. *Memory & Cognition*, *33*(4), 710–726. https://doi.org/10.3758/BF03195337

Kuijpers, M. M., Hakemulder, F., Tan, E. S., & Doicaru, M. M. (2014). Exploring absorbing reading experiences: Developing and validating a self-report scale to measure story world absorption. *Scientific Study of Literature*, *4*(1), 89–122. https://doi.org/10.1075/ssol.4.1.05kui

Kuiken, D., & Douglas, S. (2017). Forms of absorption that facilitate the aesthetic and explanatory effects of literary reading. In Frank Hakemulder, M. M. Kuijpers, E. S. Tan, K. Bálint, & M. M. Doicaru (Eds.), *Narrative absorption* (pp. 217–249). Benjamins. https://doi.org/10.1075/lal.27.12kui

Kuiken, D., & Douglas, S. (2018). Living metaphor as the site of bidirectional literary engagement. *Scientific Study of Literature*, *8*(1), 47–76. https://doi.org/10.1075/ssol.18004.kui

Kurby, C. A., & Zacks, J. M. (2008). Segmentation in the perception and memory of events. *Trends in Cognitive Sciences*, *12*(2), 72–79. https://doi.org/10.1016/j.tics.2007.11.004

Kurby, C. A., & Zacks, J. M. (2013). The activation of modality-specific representations during discourse processing. *Brain and Language*, *126*, 338–349. https://doi.org/10.1016/j.bandl.2013.07.003

Kuzmičová, A. (2014). Literary narrative and mental imagery: A view from embodied cognition. *Style*, *48*(3), 275–293. https://www.jstor.org/stable/10.5325/style.48.3.275

Lotze, M., & Halsband, U. (2006). Motor imagery. *Journal of Physiology-Paris*, *99*(4-6), 386–395. https://doi.org/10.1016/j.jphysparis.2006.03.012

Mak, M., De Vries, C., & Willems, R. M. (2020). The influence of mental imagery instructions and personality characteristics on reading experiences. *Collabra: Psychology, 6*(1), 43. http://doi.org/10.1525/collabra.281

Mak, M., & Willems, R. M. (2019). Mental simulation during literary reading: Individual differences revealed with eye-tracking. *Language, Cognition and Neuroscience*, *34*(4), 511–535. https://doi.org/10.1080/23273798.2018.1552007

Mar, R. A., Oatley, K., Hirsh, J., dela Paz, J., & Peterson, J. B. (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*, 694–712. https://doi.org/10.1016/j.jrp.2005.08.002

Miall, D. S., & Kuiken, D. (1995). Aspects of literary response: A new questionnaire. *Research in the Teaching of English*, *29*(1), 37–58. https://www.jstor.org/stable/40171422

Miall, D. S., & Kuiken, D. (2002). A feeling for fiction: becoming what we behold. *Poetics*, *30*, 221–241. https://doi.org/10.1016/S0304-422X(02)00011-6

Nijhof, A. D., & Willems, R. M. (2015). Simulating fiction: Individual differences in literature comprehension revealed with fMRI. *PLoS ONE*, *10*(2), 1–17. https://doi.org/10.1371/journal.pone.0116492

Oatley, K. (2016). Fiction: Simulation of social worlds. *Trends in Cognitive Sciences*, *20*(8), 618–628. https://doi.org/10.1016/j.tics.2016.06.002

Ostarek, M., & Vigliocco, G. (2017). Reading sky and seeing a cloud: On the relevance of events for perceptual simulation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *43*(4), 579–590. https://doi.org/10.1037/xlm0000318

Parsons, L. M., Fox, P. T., Downs, J. H., Glass, T., Hirsch, T. B., Martin, C. C., … Lancaster, J. L. (1995). Use of implicit motor imagery for visual shape discrimination as revealed by PET. *Nature*, *375*, 54–58. https://doi.org/10.1038/375054a0

Pylyshyn, Z. (2003). *Seeing and visualizing: It's not what you think*. MIT Press.

Shanton, K., & Goldman, A. (2010). Simulation theory. *Wiley Interdisciplinary Reviews: Cognitive Science*, *1*, 527–538. https://doi.org/10.1002/wcs.33

Simony, E., Honey, C. J., Chen, J., Lositsky, O., Yeshurun, Y., Wiesel, A., & Hasson, U. (2016). Dynamic reconfiguration of the default mode network during narrative comprehension. *Nature Communications*, *7*, 12141. https://doi.org/10.1038/ncomms12141

Speed, L. J., & Vigliocco, G. (2014). Eye movements reveal the dynamic simulation of speed in language. *Cognitive Science*, *38*, 367–382. https://doi.org/10.1111/cogs.12096

Speer, N. K., Reynolds, J. R., Swallow, K. M., & Zacks, J. M. (2009). Reading stories activates neural representations of visual and motor experiences. *Psychological Science*, *20*(8), 989–999. https://doi.org/10.1111/j.1467-9280.2009.02397.x

Speer, N. K., Zacks, J. M., & Reynolds, J. R. (2007). Human brain activity time-locked to narrative event boundaries. *Psychological Science*, *18*(5), 449–455. https://doi.org/10.1111/j.1467-9280.2007.01920.x

Stanfield, R. A., & Zwaan, R. A. (2001). The effect of implied orientation derived from verbal context on picture recognition. *Psychological Science*, *12*(2), 153–156. https://doi.org/10.1111/1467-9280.00326

Stich, S., & Nichols, S. (1993). Folk psychology: Simulation or tacit theory? *Philosophical Issues, 3*, 225–270. https://www.jstor.org/stable/1522947

Troscianko, E. T. (2013). Reading imaginatively: The imagination in cognitive science and cognitive literary studies. *Journal of Literary Semantics*, *42*(2), 181–198. https://doi.org/10.1515/jls-2013-0009

Van Krieken, K., Hoeken, H., & Sanders, J. (2017). Evoking and measuring identification with narrative characters – A linguistic cues framework. *Frontiers in Psychology*, *8*, 1190. https://doi.org/10.3389/fpsyg.2017.01190

van Laer, T., de Ruyter, K., Visconti, L. M., & Wetzels, M. (2014). The extended Transportation-Imagery Model: A meta-analysis of the antecedents and consequences of consumers' narrative transportation. *Journal of Consumer Research*, *40*(5), 797–817. https://doi.org/10.1086/673383

Willems, R. M., & Casasanto, D. (2011). Flexibility in embodied language understanding. *Frontiers in Psychology*, *2*, 116. https://doi.org/10.3389/fpsyg.2011.00116

Willems, R. M., Toni, I., Hagoort, P., & Casasanto, D. (2010). Neural dissociations between action verb understanding and motor imagery. *Journal of Cognitive Neuroscience*, *22*(10), 2387–2400. https://doi.org/10.1162/jocn.2009.21386

Wiltshire, T. J., Lobato, E. J. C., McConnell, D. S., & Fiore, S. M. (2015). Prospects for direct social perception: a multi-theoretical integration to further the science of social cognition. *Frontiers in Human Neuroscience*, *8*, 1007. https://doi.org/10.3389/fnhum.2014.01007

Yarkoni, T., Speer, N. K., & Zacks, J. M. (2008). Neural substrates of narrative comprehension and memory. *NeuroImage*, *41*, 1408–1425. https://doi.org/10.1016/j.neuroimage.2008.03.062

Zwaan, R. A., & Radvansky, G. A. (1998). Situation models in language comprehension and memory. *Psychological Bulletin*, *123*(2), 162–185. https://doi.org/10.1037/0033-2909.123.2.162

Zwaan, R. A., Stanfield, R. A., & Yaxley, R. H. (2002). Language comprehenders mentally represent the shapes of objects. *Psychological Science*, *13*(2), 168–171. https://doi.org/10.1111/1467-9280.00430