

In the eye of the recipient

Pupillary responses to suspense in literary classics

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Plot suspense is one of the most important components of narrative fiction that motivate recipients to follow fictional characters through their worlds. The present study investigates the dynamic development of narrative suspense in excerpts of literary classics from the 19th century in a multi-methodological approach. For two texts, differing in suspense as judged by a large independent sample, we collected (a) data from questionnaires, indicating different affective and cognitive dimensions of receptive engagement, (b) continuous ratings of suspense during text reception from both experts and lay recipients, and (c) registration of pupil diameter as a physiological indicator of changes in emotional arousal and attention during reception. Data analyses confirmed differences between the two texts at different dimensions of receptive engagement and, importantly, revealed significant correlations of pupil diameter and the course of suspense over time. Our findings demonstrate that changes of the pupil diameter provide a reliable 'online' indicator of suspense.

Keywords: suspense, literature reception, emotional engagement, pupillary responses, emotional arousal, attention

In the eye of the recipient: Pupillary responses to suspense in literary classics

The reception of narrative fiction is a highly emotional process. One example often cited in this context is the question of why readers cry when they read episodes from Tolstoy's *Anna Karenina*, even though they know that *Anna Karenina* never existed (Radford, 1975). More broadly, it still appears unclear why a reader might become totally 'lost in a book' (Nell, 1988) or might be 'transported' into a narrative world (Green, 2004). There is a growing field of research where reception

phenomena like these and their emotional aspects in particular are defined and characterized (Green, Brock, & Kaufman, 2004; Mar, Oatley, Djikic, & Mullin, 2011). In addition, there is an increasing range of research methods and tools, which serve to elucidate the parameters of literary response, especially of emotional involvement during the reception process (Dixon & Bortolussi, 2011; e.g., Altmann, Bohrn, Lubrich, Menninghaus, & Jacobs, 2014, and Hsu, Jacobs, & Conrad, 2014, for recent reports). The present study aims to investigate an important and relevant component of recipients' engagement, namely the phenomenon of suspense, and its potential physiological correlates as indicated by changes in pupil diameter.

Suspense as an outcome of text-recipient interaction

The reception of literary texts can be described as a dynamic and active process at the intersection of emotion and cognition (see Vorderer, 1996, for an overview). Even from a layperson's perspective, literary suspense can be characterized as a phenomenon which consists of several cognitive (sub-)processes, triggered and maintained by specific textual structures and accompanied by the emotional reactions of the reader. For instance, Anz (2003) describes a recipient as being in (a varying) uncertainty about the outcome of a given plot who directly reacts towards the textual stimuli, experiencing mixed emotions. Gerrig (1996) claims that "a theory [of suspense] will no doubt make references both to readers and to narrative structures: Suspense will arise when readers possessing some particular range of cognitive processes interact with particular range of narrative features" (p. 93), although he omits emotional aspects in his perspective. There is broad consensus that suspense is the essential ingredient of narratives in order to maintain the readers' attention for an extended period of time, i.e. the entire reception of (in some cases rather extensive) literary texts. However, a solely cognitive perspective on the experience of suspense might not explain readers' motivation to turn to suspense-generating reception and complex phenomena such as fascination (see Knobloch, 2003). In contrast to Gerrig's assumptions, emotional components play a crucial role in the theoretical framework proposed by Zillmann (e.g., 1996). He assumes certain cognitive processes to be a precondition for the experience of suspense, which, importantly, entails considerable emotional involvement. The social constellation within a given story and so-called affective dispositions of the recipient toward fictional characters, namely empathetic concerns for the protagonist(s), are essential for perceiving suspense (cf. Klimmt et al., 2009, for evidence from a video game study).

In contrast to Zillmann's model, Mellmann (2007) proposes that in the prototypic case of the experience of suspense, the reader has a direct and immediate emotional reaction towards a suspense-inducing trigger such as a frightening or threatening (fictional) situation. This reaction may be highly similar to the one of the character but, importantly, the reader's reaction is not especially 'mediated through' the character's emotion. For this reason, the emotions may differ between reader and protagonist. The reader reacts towards the narrated events, situations, or objects, which, according to Mellmann, can be described as direct stimuli entering the emotional processing program. Emotional reactions of the protagonist within the fictional situation might serve as additional emotional triggers for the reader.

These assumptions are very much in line with the central claims of appraisal theories of emotion (e.g., Frijda, 1986; Scherer, 2001). A basic presupposition of these theoretical accounts of emotion is that the organism's evaluation of its circumstances, i.e. the events in its environment, plays a crucial role in the elicitation and differentiation of its emotions. These emotions are seen as dynamic episodes involving a process of continuous change in all of its subsystems (e.g. cognition, motivation, physiology, expressions). Consistently, theorists propose the central emotional mechanism to be appraisal — the continuous, recursive, and subjective evaluation of an event for criteria such as novelty, intrinsic pleasantness, goal significance, agency, coping potential, and compatibility with social or personal standards. The outcome of the appraisals based on these criteria is assumed to directly trigger response patterning, including physiological reactions, consisting of sympathetic arousal during emotional episodes (e.g., Scherer, 2001; Grandjean & Scherer, 2006). The experience of suspense could be one potential outcome of continuous sequential appraisal during the reception of texts and should therefore lead to specific reactions in the recipient's mind and body.

An alternative approach for explaining the elicitation of emotions during text processing has been provided by Lang (1984), who assumes that a text describing an emotional situation can activate a corresponding emotion information network in memory. This mechanism is especially triggered when a subject is under instruction to actively imagine the event described, resulting in measurable activity in the appropriate effectors (Vrana, Cuthbert, & Lang, 1986). These accounts assume that the imagery-prompted (physiological) responses are the same as those that would occur in the actual situation but without modulations by environmental factors. There is ample evidence to suggest that imagery-prompting texts describing emotional situations elicit responses in both the central and autonomous nervous systems similar to physiological changes in corresponding emotional states (e.g. Costa, Lang, Sabatinelli, Versace, & Bradley, 2010; McTeague et al., 2009; Vrana et al., 1986). However, such a mechanism cannot account for emotions elicited

by narratives describing events that are unrelated to one's own experiences, thus having no corresponding entry in long-term memory. It is particularly difficult to assume that (fictional) narratives from other epochs or cultural contexts would match to specific memory networks in a given recipient of today. As Mar and colleagues (Mar et al., 2011) have pointed out, relived emotions are only one possibility to explain and characterize emotional engagement during the reading process. In their update of Oatley's taxonomy of the emotions of fiction (Oatley, 1995), they distinguish between aesthetic emotions (characterized by a distance towards the work of art) and those induced by the narrative world itself. These are again separated into fresh emotions versus relived and remembered emotions (Mar et al., 2011, pp. 826–827). Particularly in regard to narratives from past centuries, it seems plausible to assume that emotional responses and reading engagement derive from other processes than specific memory-related activations.

How to measure recipients' experience of suspense

One commonly used way to investigate the subjective reading experience is the use of questionnaires (cf. e.g. Green & Brock, 2000; Odağ, 2011). In the present study, the scales of reading engagement developed by Appel and colleagues (Appel, Koch, Schreier, & Groeben, 2002) were used. Of its 14 scales, seven were chosen according to the theoretical assumptions mentioned above. Besides the scale *Suspense* itself, they comprised scales of basic cognitive processes (*Ease of Cognitive Access*, *Distraction of Attention*), the emotional reactions towards the concrete plot development (*Identification*, *Emotional Involvement*) and processes on a meta-level (*Reading Pleasure*, *Immersion in a Text*).

It is worth noting that questionnaires that are filled out *after* the reception is completed reveal only the end products of these processes and require conscious evaluations. They should therefore be extended by a methodological approach that allows obtaining evidence of the processes and changes *during the course* of reception. With regard to suspense, literary texts are assumed to vary on two levels: on the one hand, texts can differ in their general level of suspense, as a given text might be more suspenseful in its plot structures and development than another. Since they occur on a global level, such basic differences can be depicted by questionnaire data. On the other hand, independent of these basic differences, it is assumed that the course of suspense is not constant or steadily increasing but rather dynamically changing over reading time (cf. De Wied, 1991, for similar assumptions on experiences of film suspense). With a post-hoc questioning, these continuous ups and downs are not measurable, as the participants tend to draw a balance over the whole text section and build an average reflecting the mean of the

experience as a whole. Furthermore, previous research suggests that bodily reactions to texts do indeed vary with the dynamic changes of emotional intensity at the text level (Wallentin et al., 2011). In contrast to 'offline' methods, another useful indicator for investigating such dynamic changes of reception processes over time could be provided by changes in pupil size.

Insights into the recipient's mind by pupillary responses

The size of pupil diameter is controlled by two muscles, innervated by both sympathetic and parasympathetic branches of the autonomous nervous system that receive input from parts of the central nervous system involved in cognitive and affective processing (e.g., Hoeks & Ellenbroek, 1993). For many decades now, researchers have explored pupillary responses as a window into the human mind. In the 1960s, Hess and Polt famously introduced pupil activity to index the 'interest value' of a series of (emotional and neutral) pictures (Hess & Polt, 1960), as well as the cognitive load of mental operations (Hess & Polt, 1964). Since then, a vast body of research has suggested that pupillary responses serve as a potent measure for human attention, both with regard to emotional processing (e.g., Bayer et al., 2011; Bradley et al., 2008; Kahnemann, 1973; Partala & Surakka, 2003; Steinhauer et al. 1983; Vö et al., 2008) and cognitive load (e.g., Nuthmann & van der Meer, 2005; Stanners, Coulter, Sweet, & Murphy, 1979; van der Meer et al., 2010; Verney, Granholm, & Dionisio, 2001). In both cases, increased attention or effort is accompanied by increased pupil dilations: the more attention, the larger the pupil size. This correlation has recently been linked to the finding that pupil activity seems to track norepinephrine release in the locus coeruleus (LC), (Gilzenrat et al., 2010; Einhäuser et al., 2008), although the neurological pathways of this relationship remain to be uncovered. The LC, a brainstem nucleus, is the primary source of norepinephrine to the brain and thus influences a large number of sensory-, attention-, and memory-related processes, ultimately resulting in preferential processing of relevant information (for a review, see Berridge & Waterhouse, 2003). Given this relation between pupil and LC activity, research has recently started to focus on the pupil as an online measure of attentional processing. In two recent studies, pupillary dilations to (external) stimulus cues were only present when these cues were attended, indicating that pupil activity does not merely reflect (stimulus-driven) sensory processing, but rather provides a window into on-going cognitive processing (Smallwood et al., 2010; Kang et al., 2014). Following on from these findings, the present study aims to employ pupillary activity as an online measure for both suspense-based attention and its emotional correlate during the reception of two different texts from literary classics.

Criteria for selection of text excerpts

The choice of texts was made on the assumption that suspense is a universal component of texts which appears not only in prototypic texts such as thrillers or crime novels, but also in literary classics. German authors gradually became skillful writers, but in general they did not consciously begin to evoke precisely calculated effects by narrative means before the 19th century. One of first German authors who was acknowledged by his contemporaries for his art of suspenseful writing was E.T.A. Hoffmann, nicknamed ‘Gespenster-Hoffmann’ [‘ghosts-Hoffmann’]. In the second half of the 19th century, authors of German realism including Theodor Fontane and Theodor Storm effectively made use of narrative devices such as suspense in order to evoke the effects they intended. The novels of Hoffmann and the German realists are still part of the canon in German schools, which indicates their familiarity among and accessibility for average German readers. In contrast, texts from the 18th century or earlier periods generally require expert historical knowledge to be read. In contrast, more recent narratives from 20th century are often influenced by modern forms of alienation, which can seem irritating to mainstream readers. For the present study, we decided not to choose these strong and possibly irritating text stimuli, however we also wanted to refrain from using invented materials. Instead, we have chosen two passages from the above mentioned classical narrative texts, which are similar in genre and style, familiar to most readers, and comprehensible without expert knowledge. The texts share a common aesthetic understanding of how to evoke suspense with the expectations of today’s readers. The two text sections chosen for the present study were written by Theodor Fontane and Theodor Storm, whose works epitomize this shared understanding of a well written narrative. Crucially for the present investigation, both sections of text differed significantly in their rated suspense according to a previous, yet-to-be published study (Lauer & Schacht, 2014). They were presented in a professional auditory version which was exclusively recorded for the experiment in order to control prosody and accentuation. During the presentation of the texts, we continuously recorded pupil size; furthermore, participants filled out questionnaires of receptive engagement after listening to each of the text excerpts. In order to receive continuous suspense measurements, we obtained continuous suspense ratings from two different samples under slightly different conditions of text presentation.

Hypotheses

The main aim of the present study was to develop a multi-measure approach for investigating the experience of suspense in recipients. First of all, we assumed the basic level of suspense would be higher in the suspenseful text (Text S) than in the 'neutral', i.e. less suspenseful text (Text N), as should become evident from our questionnaire data. Consequently, we expected differences in terms of receptive engagement, particularly, on dimensions of emotional involvement, general reading pleasure, and immersion in a text. Given the hypothesized link between suspense and attention, we expected lower rating scores on the attention distraction scale for Text S compared to Text N.

Global differences between the suspense experienced for all text excerpts should be reflected in generally higher suspense rankings for Text S in expert and non-expert ratings. Furthermore, we expected (i) quantitatively more and (ii) qualitatively stronger local changes in suspense ratings over time for Text S compared to Text N.

Finally and most importantly, assuming that the experience of suspense leads to an increase of attention and of emotional involvement, we expected to find a significant positive correlation between suspense ratings and pupil diameter. Since both attention and emotion impact changes of the pupil size in the same direction, we expect a direct relationship between suspense and our physiological measure: the higher the experienced suspense, the larger the pupil dilation.

Methods

Materials

Two sections of canonical German novels were used in the experiment. In the suspense-condition, a section of *The Rider on the White Horse* (*Der Schimmelreiter*, 1888) by Theodor Storm was presented (suspenseful text: Text S). It contained 1362 words and was taken from the final part of the novel. In this section, a storm tide rises and the dyke reeve is not only confronted with the forces of nature, but also with the machinations of his antagonist whose ignorance leads to a devastating dyke breach.

The text of the neutral condition was from *Effi Briest* (1894/95) by Theodor Fontane (neutral text: Text N). The section contained 1418 words from the beginning of the seventh chapter of the novel. In this excerpt, the newly-married protagonist Effi wakes in her husband's house and explores her new environment. In a conversation with the handmaid, Effi receives explanations of her husband's

habits and of a noise she has heard in the night, after which she has breakfast with her husband.

In order to familiarize the participants with the previous plot and the protagonists, short introductions were presented prior to both excerpts. In processes of narrative comprehension, the reader constructs situation models which are consistently updated through the integration of new information in the dimensions of time, space, protagonist, causality and intentionality (Zwaan, Langston, & Graesser, 1995). In order to equalize starting points for each of the stimulus texts in terms of a first extensive situation model, the participants were presented with short introductions which were similarly constructed with regard to these five dimensions.

The selection of both text excerpts was based on another study of our group using questionnaires in which readers ($n=176$; not overlapping with the experimental sample) were asked to rate a total of six different texts in terms of reading engagement on seven (of fourteen) scales developed by Appel and colleagues (2002). Each scale consisted of six to ten items. All texts included in this questionnaire study were sections of canonical German novels from the 19th century. The suspense condition contained E.T.A. Hoffmann's *Mademoiselle de Scuderi* and *The Sandman*, Hugo v. Hofmannsthal's *Tale of the 672nd Night*, and Theodor Storm's *The Rider on the White Horse*, while the neutral condition contained Marie v. Ebner-Eschenbach's *Das Schädliche* [The Harmful] as well as Theodor Fontane's *Effi Briest*.

The two texts employed in the present study were selected because they differed significantly on the following scales of reading engagement: *Immersion in a Text*, $F(1, 130) = 8.8, p < .01$, *Suspense*, $F(1, 130) = 26.6, p < .001$, *Emotional Involvement*, $F(1, 130) = 20.1, p < .001$, and *Identification*, $F(1, 130) = 13.3, p < .001$, all with larger scores for Text S compared to Text N. There were, however, no significant differences on the scales of *Distraction of Attention*, $F(1, 130) = 3.1, p = .080$, *Pleasure in Reading*, $F(1, 130) = 2.6, p = .107$, and *Ease of Cognitive Access*, $F(1, 130) < 1$.

For the present study, auditory versions of the stimuli texts and the corresponding introductions were recorded with a professional male actor in a recording studio for the following reasons: (i) firstly, natural reading provokes a variety of artifacts that presumably impact pupil measurements over time (e.g. by continuously subtle changes in stimulus luminance, eye movements including shifts and regressions, excessive eye movements during dozens of line breaks), and (ii) auditory text presentation allows for very precise control of presentation timing and thus avoids heavy noise in the measurement due to temporal jitter. The reading of text sections was performed by a professional actor and recorded in a professional studio specializing in audio books. As the focus of the study was to measure effects of plot suspense irrespective of prosodic suspense cues, both texts were spoken in

neutral prosody; recordings were supervised in this regard by a producer and the senior author (AS) of this article.

Since pupil dilations are ascribable to emotional responses as well as to cognitive load, it is important to control for objective text difficulty. In order to assess the reading difficulty of the two texts, a modified version of the Flesch Reading Ease test was used. The original formula was transformed in order to obtain a continuous measure of text difficulty; thus, reading ease was calculated for each sentence and not for the whole text: $FRE = 206.835 - (1.015 \times SL) - (84.6 \times ASW)$ with SL (*sentence length*) and ASW (*average number of syllables for each sentence*). Both texts obtained comparable values on the reading ease scale; mean text difficulty for Text S was 63.9, SD = 28.8 and 52.3, SD = 28.1 for Text N, whereby higher values reflect lower text difficulty.

Rating studies

Expert rating. In order to obtain a continuous and fine-grained measure of the course of suspense for both texts, eight expert readers (mean age = 29.3, SD = 3.4, 5 female, graduates of literary studies) were presented with the printed texts and instructed to use an 11-point rating scale for indicating the suspense value of each sentence; the value was noted on an interspace following each sentence. Subsequently, ratings were averaged across raters and converted from values per sentence to values per second using the auditory version of both texts.

Auditive rating. In this setting, the auditory version of both texts was presented to 16 participants (mean age = 26.3, SD = 4.2, 11 female). In a procedure adapted from Wallentin and colleagues (2011), participants were handed a transcript of each text containing a box at the end of each line. They were instructed to focus on the spoken version of the texts and to simultaneously note the suspense value of each line of text on the transcript. Two versions of each text were used which differed in line shift positions in order to obtain a more fine-grained measure of suspense. As in the expert rating, suspense values were rated on a scale from 0 to 10 and subsequently converted to suspense ratings per second. Importantly, participants of both samples were instructed to base their continuous judgments on subjective appraisal, i.e. without expending any specific effort regarding textual structures in the case of expert ratings.

Main experiment

Participants. Data was collected from 28 participants (19 female), ranging in age from 19 to 37 years (mean age = 24.8 years, SD = 3.8). All were native German

speakers and reported no hearing problems. All but one participant were right-handed (Oldfield, 1971) and had no psychiatric or neurological disorders according to self-report. Participation was reimbursed with course credit or 15 Euros.

Procedure. Upon arrival, participants were familiarized with the laboratory settings. After signing informed consent, participants were seated in a dimly lit, sound-attenuated chamber in front of a computer screen. In order to ensure optimal eye-tracking position, participants' heads were rested on a chin rest at a distance of 60 cm from the monitor. Auditory stimuli were presented using open headphones at a comfortable sound level. During auditory presentation, participants were instructed to look at the middle of a green circle displayed at the center of a screen in order to prevent excessive eye movements. The circle spanned a visual angle of $2.4^\circ \times 2.7^\circ$ and was displayed on an equiluminant grey background.

The order of texts was counterbalanced; each text was preceded by its short introduction. Between both texts (i.e. between the first text and the introduction of the second text), participants were asked to complete a questionnaire of receptive engagement (for a detailed description, see below), as well as eight of Raven's matrices for the purpose of distraction between the two texts. After participants had listened to the second text, they completed the questionnaire of receptive engagement again. The order of items was randomized in both versions of the questionnaire. The choice of the scales of receptive engagement was based on the above mentioned questionnaire study. As in the previous rating study, of the original 14 scales by Appel and colleagues (Appel et al., 2002), seven scales were chosen according to economic and theoretical criteria: the aim was to measure the emotional and cognitive aspects of the reception process, especially the factors supposed to be interrelated to the experience of suspense. The original scales were developed for the measurement of reading engagement and were adapted to the auditory presentation with minimal changes. Note that we refer to the term "receptive engagement" for the present purpose. This modified version of the questionnaire was used in the present study; the scales were as follows: *Distraction of Attention*, *Immersion in a Text*, *Suspense*, *Emotional Involvement*, *Pleasure in Reading*, *Identification*, and *Ease of Cognitive Access*. The participants rated their receptive experience on a six-point Likert-scale (1= *I do not agree at all*, 6= *I do fully agree*) for each item of a given scale. Note that we had to eliminate several items from different scales due to reliability criteria as obtained in structural equation modeling (e.g., Lauer & Schacht, 2014).

Data acquisition and preprocessing. Pupil diameter was recorded from the dominant eye of the participant using a table-mounted EyeLink 100 eye tracker (SR Research Ltd.). The head position was stabilized by means of a chin and forehead rest that was secured on the table. Following a 5-point calibration to ensure correct tracking of the participant's pupil, data was continuously recorded at a

sampling rate of 250 Hz. Offline, data was segmented into two sections, one for each text, covering the whole text. Blinks and artifacts were corrected using spline interpolation. Data was averaged across participants and down-sampled to 1 Hz.

Data analyses

Pearson correlational analyses were conducted on averaged pupil diameters, suspense vectors (both expert ratings and auditory ratings) and Flesch-Kincaid scores. Please note that after individual pre-processing and conversions, each of these measures provided continuous values at a rate of 1 Hz.

Since both texts showed an initial negative trend in pupil size (see Figure 1) reflecting physical habituation of the pupil, analyses were conducted separately for the first 300 seconds and the remaining time interval of each text (360 s for Text S and 338 s for Text N). In order to quantify these habituation effects of pupillary response, a time vector was included in the analyses as additional factor.

For each of the chosen *scales of receptive engagement*, mean values and standard deviations were calculated across items and participants and compared with paired *t*-tests between conditions.

Results

Rating studies and main experiment

Suspense ratings. Expert ratings confirmed that the suspenseful text received higher suspense ratings (Text S; mean score = 6.1, SD = 1.2) than the neutral text (Text N; mean score = 1.3, SD = 0.8), $t(7) = 9.5, p < .001$. The same pattern of results was found for the auditory ratings, mean score for Text S = 5.1, SD = 1.1, mean score for Text N = 2.4, SD = 0.6, $t(15) = 5.5, p < .001$.

For both ratings, intra-class-correlation analysis showed a high inter-rater reliability, $\alpha = .808$ (Text S) and $\alpha = .862$ (Text N) in the expert rating and $\alpha = .936$ (Text S) and $\alpha = .857$ (Text N) in the auditory rating, indicating a very high agreement between raters within each rating study. Furthermore, expert and auditory suspense ratings showed a high positive correlation for both texts, $r = .722, p = .000$ (Text N) and $r = .834, p = .000$ (Text S), indicating high consistency also between both rating vectors of the two samples.

In addition to correlations between expert ratings and auditory ratings for the whole texts, analyses were conducted separately on the initial text parts (first 300 s) and the second parts of each text. For Text S, positive correlations were found in both parts of the text, $r = .703, p = .000$, for the initial part, and, $r = .866, p = .000$,

for the second part. For Text N, a positive correlation between expert and auditory ratings was only found in the first part of the text, $r = .803$, $p = .000$, but not in the second part, $r = .002$, $p = .973$.

Initial habituation of pupil activity. During the first 300 s, pupil activity showed a pronounced habituation effect consisting in a prolonged decrease in pupil diameter (mean pupil diameter for the first part of Text S = 4.37, SD = .15, second part: mean = 4.29, SD = .1; Text N: mean for first part = 4.45, SD = .16; second part: mean = 4.19, SD = .07; please see Figure 1). This decrease was reflected in high negative correlations of pupil activity and time for both texts, $r = -.847$, $p = .000$, and $r = -.906$, $p = .000$, for Text S and Text N, respectively. Given these physiological habituation effects, analyses of the interrelation between pupil activity and suspense measures were restricted to the remaining parts of both texts.

Analyses of pupil activity and suspense measures. For the second part of Text S, correlational analyses showed significant positive correlations between pupil activity and both suspense measures, $r = .133$, $p = .011$, for the expert rating and, $r = .249$, $p = .000$, for the auditory rating, indicating that higher suspense ratings were accompanied by larger pupil dilations.

Analyses of the second part of Text N revealed that pupil activity showed a significant positive correlation only with auditory ratings, $r = .209$, $p = .000$, but not with expert ratings, $r = -.083$, $p = .128$. This is consistent with the finding of non-significant correlations between expert and auditory ratings in this part of the text reported above, and indicates that in this part of the text, suspense might have been conveyed by prosodic rather than textual suspense cues.

Additional analyses were performed in order to determine whether the correlations of suspense and pupil activity would also hold after statistically controlling for the influence of text difficulty. To this aim, auditory ratings were correlated with the unstandardized residuals of pupil activity after partialling out the influence of text difficulty. Results of these analyses are in high concordance with previous results, showing positive correlations between pupil activity and suspense, $r = .246$, $p = .000$ (Text S) and $r = .238$, $p = .000$ (Text N), respectively.

Influence of text difficulty. For both texts, reading difficulty showed no significant correlation with expert suspense ratings, $r = -.014$, $p = .721$ and $r = -.009$, $p = .811$, for Text S and Text N respectively.

Correlational analyses of continuous text difficulty and pupil activity revealed no significant correlation for Text S (second part), $r = -.037$, $p = .483$. In contrast, there was a significant negative correlation between text difficulty and pupil activity in Text N, $r = -.141$, $p = .009$, indicating that sections with higher text difficulty were accompanied by larger pupil dilations.

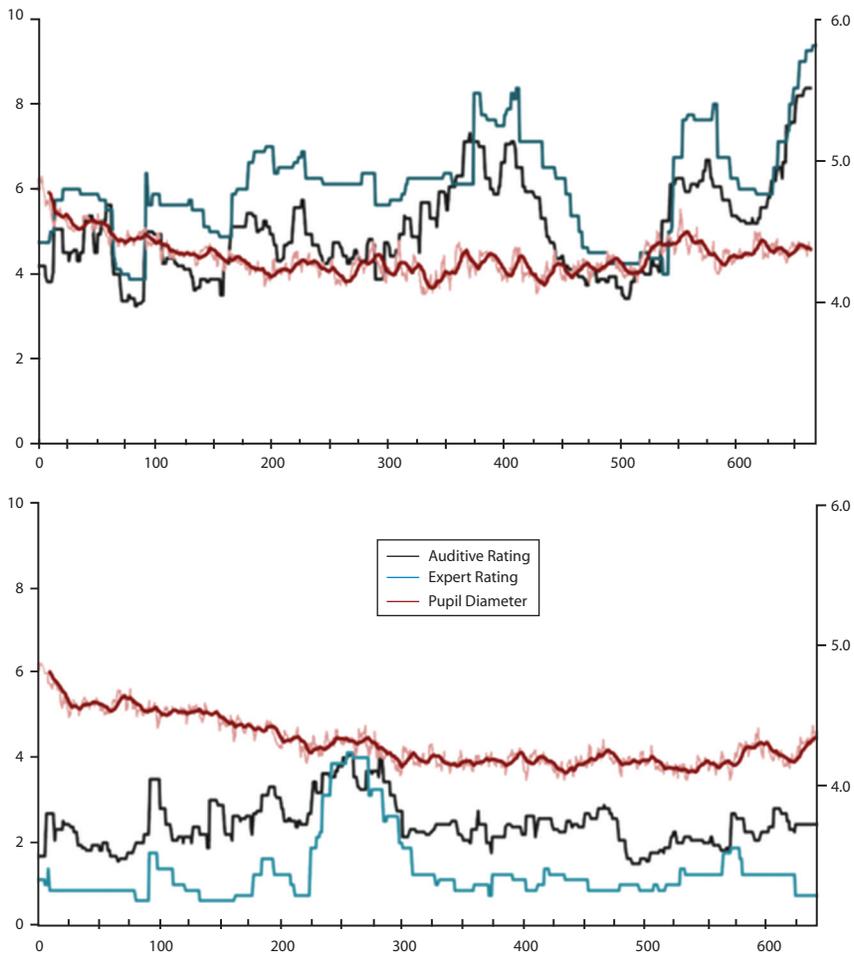


Figure 1. Averaged suspense ratings (rated on scales of 0 to 10) from experts (blue) and naïve recipients (black) in the suspense condition (Text S, top panel) and the neutral condition (Text N, bottom panel). The red line depicts the moving average of ten consecutive mean values of continuous pupil size recordings (trend line). Note that all correlation analyses are based on down-sampled raw data averaged across participants, depicted in light red.

Questionnaires

The analysis of the scales of receptive engagement with a paired t-test revealed that Text S and Text N differed significantly on two scales: *Suspense* and *Emotional Involvement* (please see Table 1 for descriptive and test statistics). Text S received higher ratings on these scales than Text N. There were no differences on the scales

Distraction of Attention, Immersion in a Text, Pleasure in Reading and Ease of Cognitive Access and a tendency on the *Identification* scale.

Table 1. Descriptive statistics (mean values and standard deviations) of the seven scales of receptive engagement for both texts, as well as results of paired t-tests between both texts.

	Distraction of Attention	Immersion in a Text	Suspense	Emotional Involvement	Pleasure in Reading	Identification	Ease of Cognitive Access
<i>Text S</i>	3.00 (1.05)	3.60 (1.04)	4.10 (1.24)	3.25 (0.98)	4.01 (0.21)	3.51 (0.76)	4.58 (0.19)
<i>Text N</i>	2.76 (0.99)	3.38 (1.03)	3.21 (1.28)	2.84 (0.78)	3.97 (0.23)	3.19 (0.62)	4.86 (0.14)
<i>t(1, 27)</i>	0.99	1.15	2.70*	2.32*	0.15	1.71	-1.43

Note * $p < .05$

Discussion

The present study aimed to analyze the phenomenon of narrative suspense during the reception of two excerpts from literary classics. For this purpose, ‘offline’ (questionnaires) and ‘online’ (continuous ratings, pupillometry) methods were combined in order to understand how the reader’s mind processes narrative structures differing in terms of overall suspense and dynamic changes in suspense over time. Most importantly, our results showed significant positive correlations between pupil diameter and the course of suspense as measured by subjective judgments of perceived suspense from experts and lay recipients over time. The analysis of the questionnaire data revealed that both text excerpts differed significantly in terms of appraised suspense and emotional involvement, whereas they were comparable with regard to cognitive accessibility.

In the introduction, we defined suspense as a mainly psychological phenomenon, which leads to an increase of attention (towards the plot) and is corroborated by emotional reactions of the reader (e.g., Anz, 2003). These emotional responses are assumed to be unspecific in terms of emotional valence, hence they do not resemble any discrete emotion (cf. Mellmann, 2007). Importantly for the present approach, we hypothesized that the reception of suspense would not be stable but dynamic, depending on the underlying structure of suspense in the respective text. This structure should then provoke several local suspense maxima, even in a less suspenseful text at the global level. The main purpose of the current study was to measure these online changes by analyzing subjective and conscious ratings of both experts and lay recipients as well as a more indirect physiological

measurement, namely changes of the pupil size registered during the reception process.

Our main finding consists of positive correlations between the different on-line indicators, namely pupil dilations and suspense ratings from both lay readers and experts. This indicates that the reception of suspenseful parts of the text excerpts was accompanied by increased pupil diameters. As outlined in the introduction, the registration of pupil diameter is an appropriate measurement to capture changes and degrees of emotional arousal on the one hand and of (online) attention on the other. Bradley and colleagues (Bradley et al., 2008) reported that the presentation of affective pictures led to increased dilations of pupil diameter in reaction towards both positive and negative in comparison to neutral pictures, indicating increased activation of the sympathetic nervous system. In contrast to emotional pictures, previous literature indicates that the processing of emotional words might not necessarily trigger the activation of the autonomic nervous system. In the context of single word processing, pupil diameter decreased when participants read highly arousing words, suggesting that the processing of emotional words does not automatically activate the sympathetic nervous system (Bayer et al., 2011). In contrast to these findings, changes in pupil diameter in the current study might reflect the dynamic increase and decrease of emotional arousal caused by changes in suspense during the reception process. From a cognitive perspective, the pupillary system has been shown to be highly sensitive to mental effort and attention capture. In the present study, we controlled our stimulus materials for differences in complexity as indicated by similar scores obtained for both texts at the *Ease of Cognitive Access* scale of the receptive engagement questionnaire. However, suspenseful passages might capture the attention of the recipient and thus cause increases in pupil size. At least in our pre-experimental questionnaire study, which had a large sample size, we obtained marginal differences in the attention-related dimension with slightly lower scores in the *Attention Distraction* scale for the highly suspenseful text excerpt. Structural equation modeling of these data indicated stronger relationships between perceived *Suspense* and *Emotional Involvement* compared to *Suspense* and *Attention Distraction* (Lauer & Schacht, 2014). With the present study, we did not aim to disentangle specific emotional and cognitive sub-processes involved but rather focused on dynamic changes of experienced suspense, particularly under conditions in which participants are not required to explicitly pay attention to their subjective experience (as it is always the case in rating and questionnaire studies). Moreover, we assume it to be the 'nature' of literary reception that both emotion and cognition are closely linked. Such strong interplay of both systems of the human mind has recently been demonstrated in a variety of different stimulus domains and modalities, including language (e.g. Bayer & Schacht, 2014; Bayer, Sommer, & Schacht, 2012; Schacht & Sommer,

2009a,b). Additionally, the analysis of the questionnaires showed that there were significant differences between the two text excerpts on two scales of receptive engagement, namely *Suspense* and *Emotional Involvement*. These findings are in line with the theoretical assumption that the experience of suspense is accompanied by emotional involvement (cf. Knobloch, 2003): the rating of the texts with the scales of receptive engagement showed that higher degrees of suspense are accompanied by increased emotional intensity. In this context, the corresponding dilations of pupil diameter can be interpreted as indications of emotional arousal; they provide empirical evidence for dynamic bodily reactions towards the aurally presented textual stimuli. For the analysis of a phenomenon like suspense, which is characterized by dynamic ups and downs, changes and fluctuations, online methods like eye-tracking present a possibility to describe punctual shifts in a detailed way. Post-hoc questionings, on the other hand, merely refer to the complete aesthetic experience based on overall appraisal; beyond that, they are also prone to interferences due to conscious evaluative processes. Both approaches have their advantages and a combination of both may lead to a broad view of elements of the reception process (Auracher, 2007; Bar-Haim, Fox, VanMeenen, & Marshall, 2004; Schacht, Pollmann, & Bayer, 2013; Wallentin et al., 2011).

Another result of our questionnaire data concerns the relation of suspense and identification with the protagonist. Whereas Text S (suspense condition) was rated higher on the scales *Suspense* and *Emotional Involvement*, there were no significant differences in terms of *Identification* between the two conditions. Thus, the current finding is consistent with the assumption that the experience of suspense is not necessarily accompanied by a higher identification of the recipient with the protagonist of the plot (Mellmann, 2007). This finding is in line with the results of a study by Cupchik and colleagues (Cupchik, Oatley, & Vorderer, 1998) where participants had stronger emotional reactions in a sympathetic spectator condition than in an identification condition, and is further supported by neuroimaging data demonstrating that the neural correlates involved in suspenseful reading are brain areas associated with mental operations, predictive inference, and cognitive control (Lehne & Koelsch, in press). Therefore, it can be assumed that the reader enters the fictional world and reacts emotionally towards the narrated events and situations without the need to 'step in the shoes of the fictive protagonists'. These findings need further investigation, above all in the context of empathetic processes during the reception process (Djikic, Oatley, & Moldoveanu, 2013; Mellmann, 2010; Wallentin, Simonsen, & Nielsen, 2013).

On top of these findings, further outcomes of the present study are worth noting. As described in the hypotheses, we expected the suspenseful text to be characterized by both higher overall suspense ratings and quantitatively more local suspense maxima compared to the neutral text. The first expectation was statistically

supported by our data: the results of continuous ratings by both experts and lay recipients showed that Text S and Text N differed significantly in terms of overall suspense, with significantly higher values for Text S than for Text N. Regarding local suspense maxima, we would like to mention that on a solely descriptive basis (please, see Figure 1), the more suspenseful text triggered a larger number of decreases and increases over time than the neutral text. In contrast to the post-hoc questionnaires, which indirectly measured the experience of suspense with items such as ‘*I wanted to know what would happen next*’, these ratings captured the continuous and immediate experience of suspense. Nevertheless, in a way, such ratings are comparable to the methodical approach of questionnaires to some extent, as their results can be regarded as the end-product of *conscious* decisions (cf. Schacht et al., 2013). Overall, inter-rater reliability was high both within and also across samples, indicating that the phenomenon of suspense is quite accessible and independent of the level of expertise. Interestingly, however, concordance between experts, who judged the suspense level using only a written version of the text excerpts, and lay participants, who were presented with their auditory version also used in the main experiment, were strongly reduced for Text N, particularly for its second half. When looking for an explanation for this finding, it seems striking that suspense was judged much lower in the second part of Text N than both in its first half and in the comparatively suspenseful Text S. In addition, as is becoming obvious in descriptive analyses of the dynamic course of perceived suspense, the second half of Text N suffers from specific increases, i.e. local maxima, of suspense. On a speculative basis, this finding might indicate that when suspense is low and indistinct, non-textual characteristics may become more important. Such aspects might be located at the recipients’ end, but also at the context level concerning the reception modality itself or the impact of the speaker’s prosody in the current study.

Finally, we would like to mention that the correlation coefficients between pupil size and rating values were moderate (e.g. $r_s > .2$ for Text S) but acceptable given the fact that they were calculated on values from different samples and different measures. Importantly, it has to be taken into account that this analysis involved physiological and non-physiological measures, which are prone to completely different types of influences and artifacts. In line with our results, comparable correlation sizes have previously been reported for physiological and non-physiological indicators over time (e.g. Wallentin et al., 2011) and therefore presumably present valid measures.

In summary, the present results show that suspense can be described as a dynamic aspect during the reception of literary texts. Most importantly, we could demonstrate that these dynamics are reflected not only in suspense ratings, but also in pupillary responses, resulting in positive correlations between pupil

diameter and ratings obtained from two independent samples. Furthermore, we found differences in the appraisal of literary excerpts at the level of continuous suspense ratings during the reception process and subsequent judgments using questionnaires. Therefore, our findings suggest that changes of the pupil diameter provide a reliable physiological indicator of suspense, which drives recipients' attention and modulates their emotional engagement. Ultimately, we hope that this study will be a step towards opening new avenues for research investigating online receptive engagement in literary as well as non-fictional texts.

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