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Generation of Emotional Inferences during Text Comprehension: Behavioral Data and Implementation through the Landscape Model

Generación de Inferencias Emocionales durante la Comprensión de Textos: Datos Conductuales e Implementación a través del Modelo Landscape

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This study investigated the generation of emotional inferences during the reading and recall of narrative texts. Experiment 1 compared the fit of two simulations of text comprehension to the recall data. One simulation examined causal and referential inferences, while the other examined causal, referential and emotional inferences. We found that the simulation that involved emotional inferences provided a better fit to the human data than the other simulation. Experiment 2 tested whether emotional inferences are generated online by recording lexical decision times at pre-inference and inference locations. Lexical decision times were faster at the inference than the pre-inference locations. These findings suggest that emotional inferences play a role in the understanding of natural texts, and that they require the reader to establish connections between text segments.

Keywords: Emotional Inferences, Landscape Model, Natural Texts.

Este estudio investigó la generación de inferencias emocionales durante la lectura y el recuerdo de textos naturales. En el Experimento 1 comparamos el ajuste de dos simulaciones de la comprensión de textos a los protocolos de recuerdo. Una de ellas contempló la realización de inferencias causales y referenciales, y la otra, la realización de inferencias causales, referenciales y emocionales. Se encontró que la simulación que implementaba la realización de inferencias emocionales brindaba un mejor ajuste a los datos de recuerdo que la simulación que no las contemplaba. En el Experimento 2, se examinó si las inferencias emocionales se generan online midiendo tiempos de decisión léxica en condiciones de pre-inferencia y de inferencia. Se encontró que los tiempos eran menores en la condición de inferencia que en la de pre-inferencia. Estos hallazgos sugieren que las inferencias emocionales juegan un rol en la comprensión de textos naturales, y que requieren que el lector establezca conexiones entre los segmentos textuales.

Palabras Clave: Inferencias Emocionales, Modelo Landscape, Textos Naturales.

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Text comprehension requires for the reader to construct a coherent mental representation, by integrating text information with his or her background knowledge. Extensive research has addressed the processes involved in the generation of inferences during the comprehension of texts, as well as the nature of the information that is activated and encoded (Graesser, Singer & Trabasso, 1994; van den Broek, 1994). Among these inferences, the generation of emotional inferences plays an important role in the comprehension of narratives, given that it involves the activation of knowledge about fictional characters' emotional states, as a consequence of story events. Several studies have suggested that the emotional states of characters of short experimenter generated narrative texts need not be stated explicitly: readers can infer them as a consequence of the narrative situation, characters' goals, actions, and relations to other characters (Calleja, Rodríguez-Santos, Torres, Garcia-Orza, 2009; de Vega, León & Díaz, 1996; Gernsbacher, 1995; Gygax, Oakhill & Garnham, 2003; Molinari, Burin, Saux, Barreyro, Irrazábal, Bechis, Duarte & Ramenzoni, 2009).

The generation of emotional inferences during the comprehension of natural texts has not received the same attention. Given the existing evidence that emotional inferences play a role in the processing of short experimenter generated stories, the purpose of this investigation was to examine the generation of emotional inferences during the reading of natural texts. That is, texts that have not been created by the experimenters. Using long and natural discourse allowed us to address some of the concerns that have been raised about the repeated used of short and artificial texts. It has been proposed that these texts might be less interesting and coherent than natural texts, and might not reflect the processes that take place when readers face them (Graesser, Magliano & Haberlandt, 1994).

In order to address these issues, we carried out two alternative simulations of text comprehension through the Landscape Model (van den Broek, Risden, Fletcher, & Thurlow, 1996; van den Broek, Young, Tzeng, & Linderholm, 1999; Tzeng, 2007), and collected behavioral data (lexical decision times) during the reading of two fairy tales. Simulating the realization of emotional inferences allowed us to test whether the realization of such inferences leads to a facilitated recall of the emotional segments of the text. Collecting behavioral data allowed us to test whether emotional inferences are generated as the reader proceeds through the text.

We focused on four emotions that have been proposed to be 'basic' (Stein & Trabasso, 1992): *happiness, sadness, anger* and *fear.* These emotions can be characterized through an analysis of the goals of the characters in a narrative (Cevasco, Molinari & Barreyro, 2008). That is, the triggering conditions for an emotion are related to the current state of the goal, the character's assessment of the changes that are necessary to attain that goal, and the probability of these changes occurring. If an event allows for a goal to be attained, the character will experience a positive emotion, such as *happiness.* If an event obstructs the attainment of a goal, the character will experience a negative emotion, such as *anger* or *sadness*. If there is uncertainty about the possibility of achieving a goal, the character will experience another negative emotion: *fear.* Given this close link between goals and emotions in narratives, and given that goals are central in the structure of narratives (van den Broek, 1994), we expected emotional inferences to intensify the global attention to the text segments that describe the triggering and enabling conditions for an emotion. As a consequence, these segments should become more salient in the reader's mental representation, and should be better recalled than the segments that do not mention any enabling or triggering conditions for an emotion.

In order to simulate the generation of emotional inferences, we used the Landscape Computational Model (van den Broek et al. 1999). This model proposes that, as the reader proceeds through a text, propositions fluctuate in activation. That is, with each reading cycle (which in this study corresponds to the reading of a new sentence), new propositions are activated, and activation values of current propositions change. In addition, the co-activation of propositions leads to the establishment of connections between them. Through these fluctuating activations, a memory representation of the text gradually and dynamically emerges. At each reading cycle, there are four sources of activation: the current processing cycle, the preceding cycle, the current text representation, and the reader's background knowledge. The current reading cycle involves the propositions that are currently being read, which are maximally activated. The preceding cycle involves the propositions that are part of the immediately preceding cycle, which are carried over and, at least in part, available for processing. The current text representation refers to propositions that were processed in previous reading cycles, which can be reactivated if required for comprehension. And, the reader's background knowledge refers to the propositions that the reader can incorporate from world knowledge acquired outside of the text. Two types of mechanisms guide access to the sources of activation. The first type is *cohort activation*. The model assumes that when a proposition is activated all other propositions currently activated become associated with it. Thus, each proposition connects with other related propositions becoming a cohort. In turn, when any of the individual propositions in the cohort becomes active, the other related propositions are also activated. The amount of activation for the secondarily retrieved propositions is a function of the strength of their relation to the primarily retrieved proposition, and the amount of activation of the primarily activated proposition. In addition, part of a proposition's cohort is the proposition itself. Its activation in subsequent cycles is a function of the proposition's activation in the preceding cycle and the strength of its self-connection, which is called *node strength.* A proposition with high node strength is more likely to remain in memory for subsequent cycles, whereas a proposition with low node strength is more likely to decay quickly. The second type of mechanism that guides access to the sources of activation is *co-*

herence-based retrieval. That is, information is retrieved with the aim of meeting a reader's standards of coherence or goals (Linderholm, Virtue, Tzeng, & van den Broek, 2004; van den Broek, Risden, & Husebye-Hartmann, 1995). These standards reflect a reader's knowledge and beliefs about what constitutes good comprehension, as well as his or her specific goals for reading the particular text (e.g., study, entertainment). For narratives, referential and causal standards of coherence are central. Referential coherence is obtained when the reader is able to identify the reference for the objects, persons, etc, that are part of the sentence that he or she is reading. Causal coherence is obtained when the reader is able to find causal explanation for the event described in the current sentence. To sum up, the Landscape model proposes that the vector of activation at each reading cycle is determined by the current text, the previous cycle, and retrieval from prior cycles or background knowledge when it's required for comprehension.

In the next sections, we will present a norming study and two experiments. The norming study allowed us to identify the points where emotional inferences should be generated in two fairy tales. In Experiment 1, we compared the adjustment of two alternative simulations of text comprehension to the recall data. In the causal referential simulation, the texts were analyzed through the causal referential theory of inference generation. In the emotional simulation, the causal referential analysis was used together with ratings of emotion provided in the norming study to implement the realization of emotional inferences. In Experiment 2, the online realization of emotional inferences was tested through a lexical decision task.

Norming study

In order to determine the points where emotional inferences are generated in two fairy tales, we asked participants to provide ratings of emotions after they had read one of them.

Method

Participants

Seventy-two undergraduate students at the University of Buenos Aires volunteered to participate in the study. The sample was drawn from introductory psychology courses.

Materials and Procedures

Materials consisted of two German fairy tales: '*Jorinde and Joringel'* and '*Rapunzel',* compiled by Jacob and Wilhelm Grimm (1812). The fairy tales were reduced from their original length to 38 sentences, in order to be entered as activation units in the Landscape simulations. This reduction did not differ significantly from the texts' original length, and did not alter the plot or leave about any central story events. Any explicit mentions to emotional reactions or states were deleted. An excerpt of one of the fairy tales can be found in the Appendix.

Four matrices were developed for each story. Each of them was used for subjects to rate the likelihood of any of the characters experiencing one of four emotions (happiness, sadness, anger and fear) in each sentence.

Participants first read one of the stories from a booklet in regular paragraph form. Once they had done this, they received the story parsed sentence by sentence and completed the matrix for one of the emotions. They did this by writing the name of the character who they thought was experiencing the emotion on one of the columns of the matrix, and rating how likely the emotion was on a five-point Likert scale (1 = somewhat likely, 5 = highly likely). Each subject read only one story, and completed the matrix for only one emotion.

Results

Those sentences that received a mean score of 2.5 ($SD < 2$) for at least one emotion were identified as emotional reading cycles. In total, 13 emotional cycles were identified for *'Jorinde and Joringel'* and 20 emotional reading cycles were identified for *'Rapunzel'*.

Experiment 1

Once we had obtained ratings suggesting the locations where emotional inferences should be generated, we examined their role in the recall of fairy tales. In order to investigate this, we conducted two alternative simulations of text comprehension through the Landscape Model.

In the causal referential simulation, the tales used in the norming study were analyzed according to the causal referential theory of inference generation (van den Broek et al., 1995). This theory proposes that the reader's standards of coherence include maintaining referential and causal coherence. That is, the vector of activation at each cycle is determined by the current sentence, carryover from the preceding cycle, and retrieval from prior cycles and background knowledge, when such retrieval is necessary for referential or causal coherence.

In the emotional simulation, the causal referential analysis was used together with the ratings of characters' emotions to implement the realization of emotional inferences. That is, this simulation assumes that the reader keeps track of referential and causal coherence, and of the emotions that characters experience as a result of story events. Given that they are prompted by the outcomes of the characters' attempts to obtain goals (Stein and Trabasso, 1992), we expected emotional inferences to intensify the global attention that the reader devotes to the propositions in the reading cycle (called '*emotional reading cycles'*). In consequence, these propositions should make a greater contribution to the formation of a mental representation, and should be better recalled than those that are part of the non-emotional cycles.

The simulation was conducted in three stages. In the first stage, the input values for each proposition were determined through the analysis of the materials. For the causal referential simulation, the input values were: 5 for the new propositions of each cycle, 4 for the reactivation of previously mentioned propositions that are correferential to the new proposition, and for the reactivation of previous propositions that are causally connected to the content of the current cycle, when the connection is of motivation (that is, one of the propositions describes a goal and the other its consequence. For example, in Rapunzel, *´the wife told the husband that she wanted to eat rampions from the garden*' and *'the husband hastily clutched a handful of rampions*'), psychological causation (one of the propositions describes an internal reaction to the event described in the other. For example: *'the wife saw the rampions'* and '*she longed for them'*) and physical causation (one of the propositions describes changes in the physical states of objects or persons as a consequence of the other. For example: *'the wife got pregnant'* and '*the wife gave birth to a child'*), and 3 for the reactivation of propositions that are causally connected to the content of the current cycle, when the connection is that of enablement (one of the propositions describes a pre-condition that is necessary, but not sufficient for the occurrence of the other. For example: *´the enchantress stood in front of the husband'* and *'the enchantress angrily yelled at him'*).

For the causal referential emotional simulation, 1 extra score unit was added to the propositions that were identified as *'emotional reading cycles'* in the norming study. For these propositions, the revised input values were: 6 for the new propositions of the current reading cycle, 5 for the reactivation of previously mentioned propositions that were correferential to a new proposition, and for the reactivation of previous propositions that were causally connected to the content of the current cycle, when the connection was of motivation, psychological causation and physical causation, and 4 for the reactivation of propositions that were causally connected to the content of the current cycle, when the connection was that of enablement. The non-emotional reading cycles kept the values that had been assigned for the causal-referential simulation.

In the second stage, the model processes the input values cycle by cycle and produces an activation matrix that contains the activation vectors. These vectors result from the computation of the cohort activation, and represent the state of working memory after reading each sentence.

In the third stage, the model establishes and updates the connections of the emergent network memory representation. Connections among propositions are based on their co-activation. That is, when two propositions that are activated at the same time, a connection between them is established. The output indicates the strength of the connections at each reading cycle, and the node strength of each proposition (that is, the total activation for each proposition across reading cycles).

Method

Participants

Forty-two undergraduate students volunteered to participate in this study. The sample was drawn from introductory psychology classes.

Materials

Materials consisted of the two fairy tales used in the norming study.

They were parsed into propositions following the procedure developed by Kintsch (1998). '*Jorinde and Joringel'* was parsed into 74 propositons, and '*Rapunzel'* was parsed into 90 propositons.

Once the texts had been parsed into propositions, we identified causal connections among them on the basis of the following criteria (Trabasso & van den Broek, 1985): *temporal priority* (a cause must come before its outcome), *operativity* (a cause must be active or in operation when the outcome occurs), *necessity* (a cause must be necessary for the event to occur, that is, one must be able to state that if the event described in proposition A had not happened, then the event described in proposition B would not have happened). For example, the sentence pair '*Brian decided he wanted a CD player. He called the store for the price of a nice model'* is causally connected because Brian's wanting a CD player occurs prior to his calling the store, is in operation when he does, and is necessary for it to happen. We identified 82 causal connections and one referential connection between pairs of propositons in '*Jorinde and Joringel'*, and 106 causal connections and 9 referential connections in '*Rapunzel'*.

Procedure

Participants were randomly assigned to read one of the two stories. Instructions told

them that they should read the story carefully, because they would be asked to complete a related task.

Participants were tested in groups of twelve or fewer. Instructions were given once for all of them. Test sessions, including instructions, averaged 15 minutes in length. All subjects completed the task within this time frame.

After reading the story, participants performed the Buenos Aires Verbal Skills Test (Cortada de Kohan, 2004) as a distractor task. Upon completion, they received written instructions to write down everything they remembered from the story.

Results and Discussion

The recall protocols were parsed in propositions, and proportions of recall for each proposition were calculated. A prop-

osition was credited as recalled if the participant was able to reproduce all or part of it verbatim, or if the gist of the proposition was accurately reproduced.

In order to compare the recall of the propositions that were part of the emotional reading cycles to those that were part of the non-emotional reading cycles, we divided the total of propositions in two groups. One of them was composed by those propositions that, according to the input matrices, had a value different from zero in at least one of the emotional reading cycles. That is, they could be correferential or causally connected to a proposition that had been proposed to prompt the generation of an emotional inference in the norming study. The other was composed by those propositions that had a value activation of zero in each emotional reading cycle. That is, those propositions that were not connected to the realization of any emotional inference by any connection. Table 1 shows the mean recall of propositions as a function of their activation (activated-not activated) in the emotional reading cycles. Difference in mean percentages of recall between both groups was significant $F(1,163) = 14.219$; $p < .001$, suggesting that those propositions that are activated in the emotional reading cycles are better recalled than those that are not.

Table 1. Mean Proportion of Recall of Propositions as a Function of their Activation in an Emotional Reading Cycle (Activated – Not Activated).

	Mean	Standard Deviation	N
Propositions not Activated in an Emotional Reading Cycle	.49	.332	59
Propositions Activated in an Emotional Reading Cycle	.67	.246	105

To compare the fit of the *causal-referential* simulation and the *emotional simulation*, the node strength of each proposition was calculated and correlated with proportion of recall. Table 2 shows the results. The node strength of a proposition predicted frequency of recall in both simulations. In the causal-referential simulation, the size of the effect was 13.6%. In the emotional simulation the size of the effect was 19.2%. These percentages indicate the explained variance in each case. We tested the difference between the coefficients of correlation following Steiger (1980), and found that it was significant, $t\ (161) = 8.02$; $p < .01$.

Table 2. Correlation between Node Strength and Proportion of Recall in the Causal-Referential and Emotional simulations

	Proportion of recall	Node strength with emotional inference	Node strength without emotional inference
Proportion of recall	1.00		
Node strength with emotional inference	.438*	1.00	
Node strength without emotional inference	.371*	.896*	1.00

$p< .001$

According to these results, the fit between the predictions from both simulations and the observed frequency of recall was high. This suggests that the causal-referential theory of inference generation accurately predicts recall as a result of the activation of propositions during the reading process. In addition, both the significant difference in mean percentage of recall for propositions as a function of their activation or not in an emotional reading cycle, and the moderate but consistently better adjustment of the emotional simulation to the data, suggest that the realization of emotional inferences facilitates not only the recall of propositions that prompt the generation of an emotional inference, but also of those that describe their causal antecedents and enabling conditions.

Given that Experiment 1 provided off-line evidence that emotional inferences play a role in the comprehension of natural texts, we run Experiment 2 in order to explore whether these inferences are generated on-line.

Experiment 2

In this experiment, we tested whether participants generate emotional inferences as they read. To explore this, participants were asked to perform a lexical decision task. This task required for them to decide whether a string of letters that would appear at selected points in the text as they read made up a word or not. Reaction times to inference words were measured in pre-inference and inference conditions. That is, immediately before, and immediately after a sentence that had been predicted to prompt the generation of an emotional inference in the norming study. This method differed from the method used in studies such as De Vega, León & Díaz's (1996) and Gernsbacher's (1995), who asked subjects to read sentences containing matching and mismatching emotional words, given that our focus was on the location where the inference is made. That is, the comparison between the pre-inference and inference locations allowed us to test whether readers generate the inferences at the locations that the causal referential model and the emotional ratings suggest that they are made, or if the emotional word is already active after reading the immediately previous sentence.

We expected that, if the reader has made the emotional inference, he or she should respond faster that an inference word is a word if it was presented at the locations that are expected to require the inference (*inference condition*), than to the same word presented immediately before these locations (*pre-inference condition*). For example, if the reader has inferred that the protagonist is '*angry*' at a specific location in the text, he or she should respond faster that '*angry'* is a word, than if the same word is presented at a location were there are no indications of such an emotion in the character.

Method

Participants

Thirty-two undergraduate students volunteered to participate in the study. The sample was drawn from introductory psychology classes.

Materials

The same fairy tales used in the norming study and Experiment 1 were employed.

For each tale, two of the sentences that were proposed to require the realization of emotional inferences were selected. A target word describing the inferred emotion was identified. Target words were high frequency words, and two/ three-syllables long. Three extra locations were selected for the presentation of pseudowords, which were created by changing the consonant of the second syllable of real words (for example, we presented '*piaco'* instead of '*piano'*), and ranged between 2-3 syllables. That is, each participant was presented with a total of 4 target words, and 6 pseudowords considering the two fables together.

Procedure and Design

Participants were tested individually, in sessions that lasted around 15 minutes. Instructions told them that they would read a story on the computer, and have to perform a lexical decision task. In order to perform this task, they would have to decide whether a string of letters that would appear on the screen at selected points in the text made up a word or not.

The texts were presented sentence by sentence. A sentence remained on the screen until the participant pressed the "+" key on the response box, and then the next sentence appeared. At selected points the story was interrupted, and after 1000 ms a string of letters appeared. It remained until the participant pressed the "*Y*" or "*N*" keys on the response box. A practice text was presented before the story to familiarize participants with the task.

The experiment was controlled through the Mel 2.0 software (Schneider, 1988).

There were two conditions: pre-inference and inference. In the pre-inference condition, the letter strings were presented immediately before the locations that were predicted to elicit the emotional inferences according to the emotion ratings in the norming study. In the inference condition, the letter strings were presented at the locations that were predicted to elicit the emotional inference. Each participant was randomly assigned to receive half the target words in the pre-inference condition, and half in the inference condition. That is, they were randomly assigned to receive the first target word in the inference or pre-inference condition, the second in the pre-inference or inference condition, and so on.

Results and Discussion

Responses that were more than 3 standard deviations from the mean reaction time were excluded from the analysis. This represented 2.5% of the data.

Mean lexical decision times were submitted to a one-way analysis of variance (ANOVA), with probe location (pre-inference, inference) as the independent variable. An alpha level of .05 was used to determine the significance for all analyses. Only items that were correctly answered in the lexical decision task were included. Table 3 shows the mean lexical decision times for each condition.

Table 3. Mean Lexical Decision Times (in ms) as a Function of Probe Location (Pre-Inference vs. Inference Conditions).

	Mean	Standard Deviation	N
Emotional word in Pre-inference location	956.91	418.62	32
Emotional word in Inference location	819.56	269.99	32

Results showed that there was an effect of probe location $F\,(1,31) = 4.945$; $MSE = 61038.415$, $p < .05$ on lexical decision times. That is, those target words representing emotional inferences that were presented at the locations for which the emotion ratings predicted the generation of emotional inferences were responded to faster than the same emotion words presented immediately before these locations. These results provide evidence that emotional inferences are generated online at the points that the participants` ratings suggest they are generated. Yet, in order to rule out the possibility that the inferences had been prompted by the single sentences that precede the presentation of the target emotional words, and not by the connections that the reader establishes among the propositions that prompt them, we tested 16 additional undergraduate students. These participants were asked to read the same sentences that had preceded the presentation of target words in the pre-inference and inference conditions, and the same target words, but in isolation. That is, the target words were presented either after the sentence that was expected to prompt the inference or after the immediately previous sentence. Each participant was randomly assigned to receive half the target words in each condition. There were no more sentences provided to the participants. In total, each participant was presented with 10 sentences: 4 sentences followed by target words, and 6 sentences followed by pseudowords. Mean lexical decision times were submitted to a one-way ANOVA, with probe location (pre-inference, inference) as the independent variable. Table 4 shows the results.

The difference between the pre-inference and inference conditions was not significant when the sentences were not accompanied by the text, $F(1, 15) = .224$; $MSE = 75524.45$, $p = .64$. That is, emotional target words do not seem to be more available after reading individual sentences that make them more available in the context of a story, than after reading sentences

that do not make them more available with or without the accompanying story. This suggests that emotional inferences are not generated as a product of isolated sentences, but rather as a result of integrating the events and actions described in the text.

Table 4. Mean Lexical Decision Times (in ms) as a Function of Probe Location (Pre-Inference vs. Inference Conditions).

	Mean	Standard Deviation	N
Emotional word in Pre-inference location	903.91	365.98	16
Emotional word in Inference location	949.91	254.48	16

General Discussion

This study investigated the realization of emotional inferences during the reading of natural texts.

Two experiments and a norming study were conducted. The norming study allowed us to establish the locations in two fairy tales where emotional inferences should be generated. In Experiment 1, we compared the adjustment of two alternative simulations of text comprehension to the recall data. The causal referential simulation implemented the realization of referential and causal inferences. The emotional simulation implemented the realization of referential, causal and emotional inferences. In Experiment 2, we used a lexical decision task to test whether emotional inferences are generated online.

Results from Experiment 1 indicated that the emotional simulation provided a better adjustment to the human data than the causal referential simulation. That is, the node strength of a proposition (its total activation across reading cycles) predicted frequency of recall in both simulations, but to a greater extent in the simulation that contemplated the realization of emotional inferences. Also, we observed that the propositions that were part of the emotional reading cycles were better recalled than those that were not. These findings suggest that the propositions that are part of the emotional reading cycles play an outstanding role in the construction of a coherent text representation. That is, the realization of emotional inferences seems to intensify the attention that the reader devotes to the entire cycle (which includes the proposition that prompts the inference, and also those that are causally connected to it), facilitaing its later recall. This intensified processing can be related to the role that chacters' emotional reactions play in a narrative. Narratives revolve around characters' attempts to attain goals. In turn, the impact of each outcome on the possibility of attaining the goal (making it more or less attainable) leads to an emotional reaction in the character. In order to infer these emotions, the reader needs to establish causal connections among the events that describe goals, attempts, and their outcomes.

Converging online evidence that emotional inferences are generated was obtained in Experiment 2. Emotion words presented at the locations where participants' emotion ratings predicted the generation of emotional inferences (inference locations) had shorter lexical decision times than the same words presented immediately before those locations (pre-inference locations). This result suggests that emotional inferences are generated as the reader proceeds through the text, at the points that participants' ratings indicate that they are generated. This facilitation does not appear to result from reading individual sentences, given that we found no difference in lexical decision times when the sentences that were part of the pre-inference and inference locations were presented in isolation. It, then, seems that it is the connections that the reader can establish among the events and actions described in the story that makes the emotion words more or less available.

Findings from this investigation extend previous work on emotional inferences (Calleja et al., 2009: de Vega et al., 1996; Gernsbacher, 1995; Gygax et al., 2003; Molinari et al., 2009) by approaching their study through the use of natural texts. It has been proposed that experimenter created texts might not reflect the processes that take place during the reading of non-artificial texts (Graesser et al., 1994). By using fairy tales as materials we were able to propose that emotional inferences play a role during their processing and recall, extending the conclusions that have been reached with artificial texts to these types of materials.

Another possible contribution of this study is that it focused both on readers' processing during reading (i.e., collection of lexical decision times) and on the final text representation that they construct (i.e., collection of free recall protocols). By obtaining both online and offline evidence that emotional inferences are generated, we were able to provide a more comprehensive picture of the realization of these inferences than if we had just focused on one of these measures.

The results of this study also suggest that the Landscape Model (van den Broek et al., 1996; 1999) is a useful tool to explore the realization of emotional inferences. The simulations that we conducted (causal referential and causal-referential-emotional) allowed us to propose that the propositions that are related to the realization of emotional inferences receive an extra activation, which leads them to be more easily recalled than the propositions that are not related to the realization of such inferences.

This study focused on the processing of characters' emotions. An interesting question for future research can be related to the role of readers' emotions in the processing of texts. Do readers experience similar emotions than the ones they infer in the characters? Do they recall better the propositions that prompt emotional reactions in them? Does this depend on reading goals?

In conclusion, findings from this investigation extend previous work on the realization of emotional inferences by approaching the online and offline comprehension of natural texts, and by providing evidence that emotional inferences are generated as readers move through the texts, as a consequence of establishing connections among its segments.

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Appendix

Excerpt of the fairy tale *´Rapunzel´* used in Experiments 1-3.

1. There were once a man and a woman who had long in vain wished for a child.
2. Finally, the woman got pregnant.
3. These people had a little window at the back of their house from which a garden that belonged to an enchantress could be seen, where no one dared to go into.
4. One day the woman was standing by the window, and she saw a bed which was planted with the most beautiful rampion, and she longed for it.
5. She told her husband "if I can't get some of the rampion, I shall die."
6. In the twilight of the evening, he clambered down over the wall, hastily clutched a handful of rampion, and took it to his wife.

7. The next day she longed for it three times as much as before.
8. The husband let himself down again; but when he had clambered down the wall he saw the enchantress standing before him, yelling at him.
9. He apologized the best he could, explaining that his wife was pregnant.
10. Then the enchantress said to him, "I will fogive you, and allow you to take away with you as much rampion as you want, but you must give me the child which your wife will bring into the world."
11. The man consented to everything.
12. When the woman gave birth to a girl, the enchantress appeared at once, gave the child the name of Rapunzel, and took it away with her. PSEUDOWORD: PIACO
13. Rapunzel grew into the most beautiful child under the sun.
14. When she was twelve years old, the enchantress shut her into a tower, which had neither stairs nor door, but quite at the top was a little window.
15. When the enchantress wanted to go in, she placed herself beneath it and cried, 'Rapunzel, Rapunzel, let down your hair to me'.
16. Rapunzel had magnificent long hair, and when she heard the voice of the enchantress she unfastened her braided tresses, wound them round one of the hooks of the window above, and then the hair fell down, and the enchantress climbed up.
17. One day the king's son rode through the forest, saw Rapunzel through the window and heard her sing so charmingly that the felt completely in love with her.
18. The king's son wanted to climb up to her, and looked for the door of the tower, but none was to be found.
19. He rode home, but the singing had so deeply touched his heart, that every day he went out into the forest and listened to it.
20. Once he saw that an enchantress came there, and he heard how she cried, "Rapunzel, Rapunzel, let down your hair".
21. The prince then understood what ladder allowed one to climb to the tower.
22. When it grew dark, he went to the tower and cried, "Rapunzel, Rapunzel, let down your hair".
23. Immediately the hair fell down and the king's son climbed up.
24. At first Rapunzel took a step back from the prince, but then she liked him so much that he started visiting her every day.
25. One day Rapunzel asked the enchantress "Why is it that my dresses do not fit me any more and my belly is growing?" PRE-INFERENCE LOCATION- TARGET WORD: *anger*
26. "Ah, you wicked child", cried the enchantress realizing that she had been deceived.

INFERENCE LOCATION- TARGET WORD: *anger*