The Effects of Interactive Emotional Priming on Storytelling: An Exploratory Study*

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Abstract. We propose that emotional priming may be an effective approach to scaffold the creation of rich stories. There are relatively few emotion-based approaches to support users to create, instead of consume, rich stories. Emotional priming is the technique of using emotion-related stimuli to affect human's executive control and affective processing. It has been researched mostly in terms of human's behaviors and decision making. We conducted a within-subjects study with 12 participants to investigate the effects of emotional priming induced through an interactive application on storytelling quality. Two conditions of priming were compared to a baseline condition of no priming. In the first condition, the application primes participants by having asking them to perceive and recognize varying emotional stimuli (perception-based priming). In the second condition, the application primes participants by having them produce varying emotional facial expressions (production-based priming). Analyses show that emotional priming resulted in richer storytelling than no emotional priming, and that the production-based emotional priming condition resulted in statistically richer stories being told by participants. We discuss the possibility of integrating interactive emotional priming into storytelling applications.

Keywords: Storytelling · Emotional priming · Facial recognition.

1 Introduction

Emotions are central to the experience of engaging in storytelling, not just during storytelling but also before and after engagement [19]. Products that can deliver more emotionally rich story experiences are more fascinating because audiences or consumers become emotionally attached to the artifacts [8, 24]. There is quite some research that use users' emotions to enable computers to be effective storytelling agents, e.g., emotional storytelling robots can observe their listeners and adapt their style in order to maximize their effectiveness [7], AI experience managers can predict the players emotional response to a narrative

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event and use such predictions to shape the narrative to keep the player on an author-defined emotional curve [15]. Generally in previous work, storytellers' emotions have been used as input to modify features of the story plot, or as an element of character models, e.g., to adjust story characters' behaviors based on users' emotions recognized from linguistic expression [4], or changing the overall narrative according to users' captured emotions [18].

Surprisingly, we found fewer emotion-based approaches to support users to create, instead of consume, rich stories. In this paper, we propose that emotional priming may be an effective approach to scaffold the creation of rich stories. This paper presents a within-subjects study that investigates the effects of emotional priming, enabled through interactive means, on users' storytelling ability, and wraps up with a discussion of the design implications for interactive digital storytelling support interfaces.

2 Background and Related Work

2.1 Emotions and Story Authoring Applications

Emotion plays a substantial role in guiding our behaviors and decision making [16, 25]. Many applications use various emotion-sensing technologies to analyze users' mental states and adjust system states accordingly. These often use facial expressions as an index of affective arousal [10], or attempt to understand expressions to determine adaptive activities [22]. For example in *StoryFaces*,the tool invites children to capture their facial expressions and combine them with drawings and animations to create dynamic stories [21].

Emotions have also been integrated in interactive story authoring applications using technologies besides facial recognition. *SenToy* [11], for instance, is a doll-like tangible interface that allows the users to manipulate it in order to express emotions while engaged in storytelling. Results showed that the emotions that were expressed with SenToy generally aligned with the users' self-report of their emotions during storytelling after the creative process. In Cavazza et al.'s work [4], the storytelling system allowed the user to participate in dialogue with virtual actors without constraints on style or expressivity to create a story. Advanced speech recognition was used to determine the user's emotions. The system mapped the recognized emotional categories to narrative situations and virtual characters' feelings, thereby driving the characters' behaviors in the story.

In prior work such as the above and references [3, 12, 13, 23], emotions were captured and recognized during the process of storytelling in order to guide storytelling in the final story output. This is conceptualized in Figure 1.

2.2 Emotional Priming Theory

Inspired by emotional priming theory, we propose that instead of emotions acting as a modifier of story output (in real-time or post-hoc), as shown in Figure 1, emotions may play a different role by framing the user in a more active state of

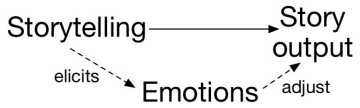

Fig. 1. Role of emotions in existing story authoring applications

mind in preparation for storytelling. This allows the storytelling process itself to be unhindered by the need for intensive monitoring (e.g., facial recognition while the user is telling her story), with potentially similar benefits in terms of more emotionally rich stories.

Emotional priming is the act of modifying someone's behavior and actions through subliminal stimuli. Essentially, subliminal emotional stimuli are used to alter moods and therefore trigger a particular response [27, 9], for example, to affect affective judgments. Emotional priming is considered fundamental evidence for unconscious perception and its strength is predicted by perceptual awareness levels [17]. Specifically, valenced emotional concepts can be nonconsciously activated, remain inaccessible to conscious awareness, and still affect behavior in an emotion-specific fashion [28]. fMRI studies suggest that emotional priming effects trigger specific regions of the brain that handles emotions [14].

Prior work on emotional priming typically prime participants for specific moods (e.g., showing sad pictures to prime for sadness). In our work, we are interested in priming participants for attention to emotions in general (i.e., not specific emotions per se). Our proposed process is illustrated in Figure 2, which can be contrasted to the process in Figure 1. Users are primed to be in an emotionally attentive state *before* the act of storytelling or story creation. In the bulk of literature on emotional priming, participants are primed by requiring them to watch a series of emotionally-specific stimuli (e.g., pictures of happy moments). We posited that emotional priming can also be achieved through the act of producing and embodying emotions rather than simply perceiving them, thus warranting interactive support systems.

Fig. 2. Proposed approach with emotional priming

3 System Description

To investigate the promise of our proposed approach of emotional priming, we implemented a gamified emotional priming system that is similar to a typical rhythm game like *Guitar Hero*. The system visually presents participants with

stimuli that fall from the top of the screen to the bottom of the screen. The participant needs to respond to the stimuli by the time the text reaches the bottom of the screen (pink area in Figure 3). Three variations of the system were created for three study conditions: 1) emotional priming through emotion perception: users perceive and recognize existing emotions; 2) emotional priming through emotion production: users generate facial expressions matching specific emotions; and 3) no emotional priming.

In the system for condition A, the stimuli consist of emojis (facial expressions) and the response required from the participant is to press a key corresponding to the specific emoji emotion (see Figure 3 right). In the system for condition C, the stimuli consist only of directional arrows, and the participant's response is to press the corresponding arrow key on the keyboard (see Figure 3 left).

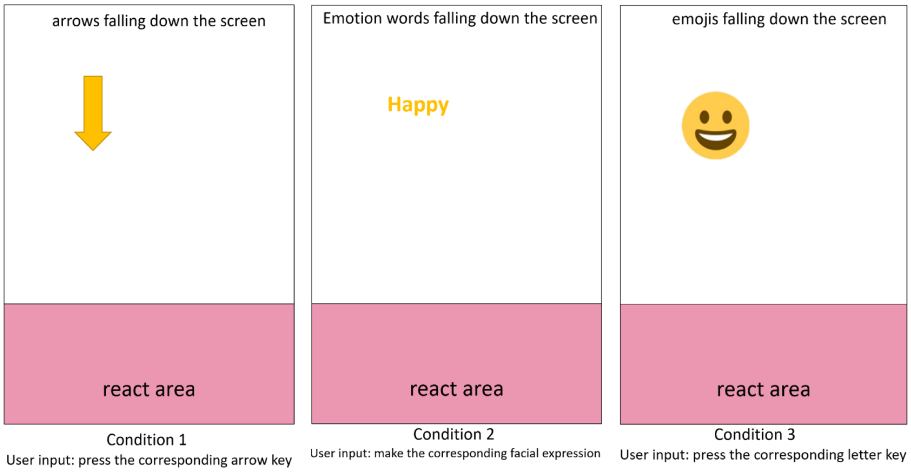

Fig. 3. Gamified interfaces used for each condition

In the system for condition B, the stimuli consist of words indicating emotional states (e.g., "happy"), and the participant's required response is to produce the indicated facial expression (see Figures 3 middle and 4). The system then recognizes the participant's facial expressions and maps it to an emotion. The facial expression recognition component of our system used convolutional neural networks to classify emotion/facial expressions based on the FER2013 dataset. We achieved real-time detection using visual-based methods [1]. Four emotions can be identified by the system: happy, angry, sad, and surprise.

In all the 3 system variations, points were awarded if the correct response was given in time. The game component was designed as a Java Standalone application, with graphics developed using AWT and Swing libraries. We also developed a sub-component for components-communication, allowing the video-

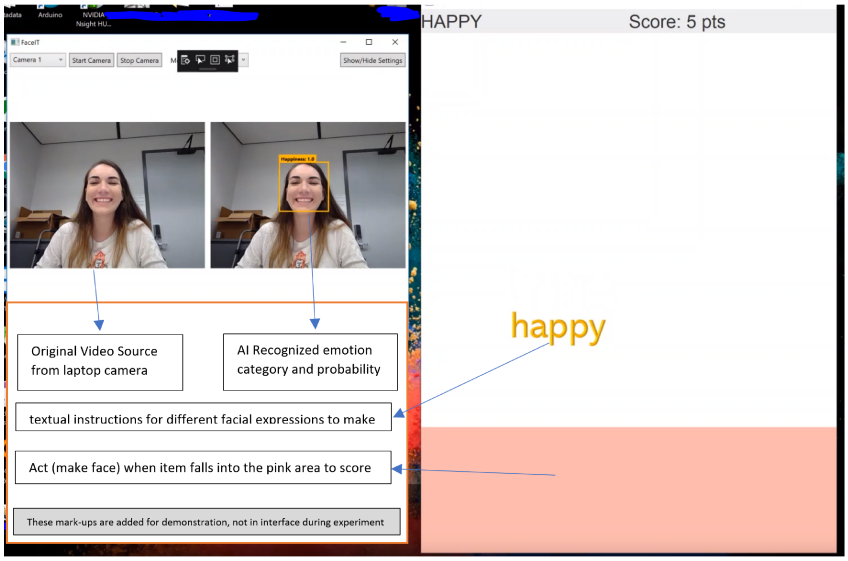

Fig. 4. Emotional Priming Interface - Researcher's view

game component to gather the user's input through the system clipboard which contained the recognized facial expression.

4 Study Description

Using the three system variations, we addressed the following research questions:

RQ1: Are there significant differences in storytelling quality after emotional priming?

RQ2: Are there significant differences in storytelling quality after perception-based emotional priming as opposed to production-based emotional priming?

The study was carried out in the lab, and used a within-subjects design with emotional priming as the single independent variable (3 levels: perception-based emotional priming; production-based emotional priming; no emotional priming). We had a total of 12 study participants, 5 males, and 7 females. All were university students. They were recruited through university listservs. They were compensated with course credit. A participant participated in only one study session during which he/she engaged in 3 conditions.

Two types of storytelling tasks were given to participants: i) one prompted by pictures, and ii) the other prompted by a text phrase. For the picture-prompted storytelling task, 6 paintings (Figure 5) by the American artist Norman Rockwell were used. These were selected for their potential emotional content and because they were unlikely to be known by participants, thereby eliminating preconceived biases about the paintings. For the text-prompted storytelling task, the following phrases were used: "a child and an animal in the woods"; "an adult and a child

and a lake"; and "two children take a walk". The phrases were purposefully left to be ambiguous so that participants can have freedom to create a story.

Fig. 5. Two example images used in study

The order of study/interface conditions was counterbalanced across all participants. We also randomized the story prompts given (within type of story prompts) across study conditions. E.g., for the text-based prompts, some participants received the phrase "two children take a walk" for the perception-based emotional priming condition, while other received the same prompt for the no emotional priming condition, etc.

For each study condition: (1) The participant used the designated system for two minutes; (2) The participant was shown a first image selected randomly out of the 6 paintings chosen for the study, and given 30 seconds to think up a story about that picture; (3) The participant was asked to tell the story to the researcher immediately after. Research has shown that priming effects tend to fade after 5 mins [2]; (4) Steps 2 and 3 were repeated with a second randomly selected image from the set (excluding the images already presented to the participant before); (5) The participant was given a randomly selected text prompt out of the 3 text prompts, provided 30 seconds to think about a story relating to that prompt; and (6) The participant was asked to tell that story.

In-between conditions, the participant was given a 3-minute break to reset their state of mind. After all 3 conditions, the participant was asked to fill out a questionnaire and underwent an interview about the overall experience. The study took about an hour per participant. The full protocol can be found here: https://drive.google.com/file/d/1FgzvrfWUX9hC0AbdxJcZJ-upMxaAy3YT.

5 Data Collection and Analysis

Participants were video recorded throughout all the three conditions. We transcribed the stories that the participants told in each condition. To analyze the quality of the stories, each story was first broken down into an 'idea digest' [20]. The idea digest deconstructs a story into individual units of thought or essence of meaning, and has been used as a method of story analysis in previous storytelling research (e.g., [6]). The meaning deconstruction can even occur within

sentences. For example, a story sentence reading "She ate it and felt really special and found out she could fly!" would be broken down into 3 ideas: "She ate it", "and felt really special", "and found out she could fly!".

After an idea digest had been extracted for each story, it was coded for *richness descriptors*, which we operationalized as adjectives, nouns used as adjectives, adverbs, and descriptive verbs. This generated a 'story quality score'. A similar process to generate a story quality score was used in Chu et al. [5]. We standardized the value of the story quality scores in two ways: by word count and by the total number of ideas identified in the story. Thus, even if a story was significantly shorter than another, we could still comparatively gauge a sense of its richness. Paired-samples t-tests were run on the story quality scores standardized by word count and standardized by the number of ideas to see if there were statistically significant differences between the quality of the stories being told after using different interfaces.

6 Results

Since each participant had 9 stories, 108 stories were collected in total for 12 participants. ANOVA showed that means differed statistically significantly between the quality of the stories being told after 3 levels of emotional priming stimuli (when standardized by word count, $F(2, 70) = 35.31$, $P < .001$;when standardized by the number of ideas, $F(2, 70) = 45.66$, $P < .001$). Post hoc tests using the Bonferroni correction revealed that pairwise differences exist among all 3 comparisons for all 3 levels of emotional priming stimuli.

When standardized by word count, participants told richer stories after production-based emotional priming ($M = .11$, $SD = .036$) as opposed to perception-based emotional priming ($M = .089$, $SD = .028$); $t(35) = 4.10$, $p < .001$. The difference was even larger between production-based emotional priming and no emotional priming ($M = .064$, $SD = .021$); $t(35) = 6.90$, $p < .001$.

When standardized by the number of ideas, participants told richer stories after production-based emotional priming ($M = 1.25$, $SD = .40$) as opposed to perception-based emotional priming ($M = .91$, $SD = .18$); $t(35) = 4.95$, $p < .001$. The difference was even larger between production-based emotional priming and no emotional priming ($M = .63$, $SD = .21$); $t(35) = 7.88$, $p < .001$.

On average across the two standardization methods, the average story quality score told after production-based emotional priming was 1.32 times higher than for perception-based priming, and 1.88 times higher than no emotional priming. An example scatter plot is shown in Figure 6. The full results can be found here: https://drive.google.com/open?id=1XObOjdEkOfjGgHaUdTSpQ7mMbwYoAAZ6.

7 Discussion and Conclusion

Based on emotional priming theory, we proposed a new approach to support users to create rich stories. In our study, emotional priming was achieved through a gamified emotional priming system that prompts users to constantly produce

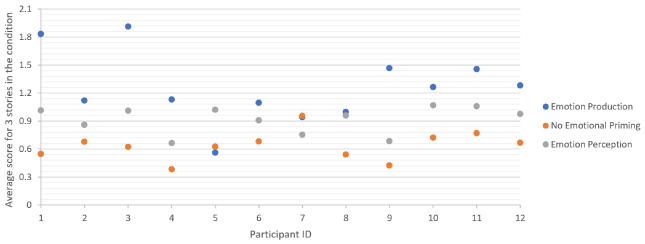

Fig. 6. The story quality scores standardized by the number of ideas

or perceive certain emotions. We found that emotional priming in general led to participants creating statistically significantly richer stories as opposed to no emotional priming (answering RQ1), and that production-based emotional priming produces richer stories than perception-based priming (answering RQ2).

To the best of our knowledge, our study results are the first to show that storytelling quality can be improved through subliminal emotional priming.

This warrants future research into how emotional priming can be integrated into IDN authoring systems. Emotional priming can be a pre-activity before storytelling to prepare storytellers for producing richer stories. A 2-minute emotional priming process is neither exhausting nor time-consuming, and can be fashioned in different ways. For the sake of clarity in the study procedures, we utilized a gamified application separate from the storytelling process but other means more integrated with the story authoring application can be envisioned. In fact, in the interview at the end of our study, many participants told us that the gamified experience was interesting and fun, and that they did not suspect its connection with the storytelling activity.

Another of our findings is that producing the emotions are more powerful than perceiving the emotions in terms of emotional priming. This result aligns with previous perception research, specifically attention and multiple resource theory [26]. The production-based emotional priming application demands more cognitive resources than perception-based priming and thus has stronger priming effects. This suggests that interactive production-based emotional priming which is validated by facial expression recognition may be a useful mechanism to support rich story creation.

Some limitations of this work are that first, although 108 stories were analyzed in total, we had only 12 participants for this study. In the future, a larger sample size is needed. Second, the stimuli used in the perception-based priming application was different than in the production-based priming application. One used emojis whereas the other used words. This was necessary for us to differentiate the two types of emotional priming. And third, the storytelling activity was rather short. Only 30 seconds were given to participants to create a story. This was so that the study could be kept within a reasonable total duration that would not tire out participants. A more complex storytelling activity can be allowed in future research. Furthermore, future research should investigate

whether story creation through other means than oral storytelling (that we did in our study) is affected by interactive emotional priming.

This paper demonstrated the effects of applying emotional priming on the creation of rich stories, and discussed possibilities for opening up a new avenue for IDN research.

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