Interactive Children's Story Rewriting Through Parent-Children Interaction

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Abstract

Storytelling in early childhood provides significant benefits in language and literacy development, relationship building, and entertainment. To maximize these benefits, it is important to empower children with more agency. Interactive story rewriting through parent-children interaction can boost children's agency and help build the relationship between parent and child as they collaboratively create changes to an original story. However, for children with limited proficiency in reading and writing, parents must carry out multiple tasks to guide the rewriting process, which can incur high cognitive load. In this work, we introduce an interface design that aims to support children and parents to rewrite stories together with the help of AI techniques. We describe three design goals determined by a review of prior literature in interactive storytelling and existing educational activities. We also propose a preliminary prompt-based pipeline that uses GPT-3 to realize the design goals and enable the interface.

1 Introduction

Storytelling in early childhood can enhance language and literacy development and contribute to improved oracy, listening, reading, and writing skills later in life (Mello, 2001; Peck, 1989). When interaction is added to the storytelling experience—for example, a storyteller asking a child a question—the attention of the child can be maintained. Enhancing the children's engagement can increase the educational benefits of interactive storytelling (Ligthart et al., 2020; Kotaman, 2020). Therefore, researchers have developed a number of technologies to support interactive storytelling for young children, which range from letting children record and playback stories (Cassell and Ryokai, 2001; Budd et al., 2007) to asking children to answer comprehension-based questions (Zhang et al., 2022) or illustrate stories (Rubegni and Landoni, 2014).

In engaging children with interactive storytelling, three aspects of agency are important: autonomy, competence, and effectance (Roth and Koenitz, 2016; Murray, 2017). Children feel more engaged if they feel more autonomous and competent in their decision-making (Ryan et al., 2006). Also, it is important to make children feel their decisions have an immediate (local effectance) and overall (global effectance) effect on the narrative (Klimmt et al., 2007). As an example of interactive stories that support these aspects of agency, *"pick-a-path"* or *"choose your own adventure"* stories can maintain children's engagement by providing different plots that children can explore depending on their choices about the plot (Green and Jenkins, 2014).

Like "pick-a-path" stories, story rewriting can be one of the activities to support children's agency in interactive storytelling in that a child makes decisions (autonomous and competent) and the story changes according to this decision (effectance). Though it is well known that story rewriting activities are helpful for developing storytelling and reading comprehension skills (Lin et al., 2021), it is challenging to provide the rewriting activities to children with limited proficiency in reading and writing. As children may struggle to rewrite stories by themselves, parents could help them by participating in this activity. Based on existing rewriting activities and literature on scaffolding children's story writing and constraints from younger children's lack of proficiency in reading and writing (Spycher, 2017; House&Museum, 2020), parent-children story rewriting can be composed of the following processes: (1) changing the setting and finding what to change in the story, (2) parents asking questions to their children about how they might want to change the story, and (3) rewriting the story based on the children's decisions. However, it is difficult for parents to carry out these processes alone, because parents have been shown to struggle in similar multitasking scenarios such as provid-

ing story-relevant questions while storytelling due to the high cognitive load incurred (Zhang et al., 2022).

Instead of burdening parents, a viable solution for parent-children story rewriting can be to adopt a human-AI collaborative approach. AI models can quickly and automatically perform tasks that can be tedious for humans, while allowing children and parents to focus on the tasks that increase the children's agency and build parent-child relationships. Specifically, entity extraction, question generation, and text generation techniques from recent natural language-based AI technologies can reduce the load on parents in the aforementioned processes of story rewriting, allowing them to focus more on the interactions with their children. Therefore, in this work, we introduce design sketches of our interface that supports children to rewrite the story through parent-children interaction with the help of AI techniques. Specifically, the system can help parents using a three-step pipeline: (1) finding entities in the story that could be changed based on a set of pre-defined dimensions from literature, (2) generating questions that a parent can ask their child to decide on how to rewrite, and (3) rewriting stories based on the child's decisions while keeping coherency with prior context.

2 Design Goals

This work focuses on supporting interactive rewriting of children's stories through parent-child interaction to provide children with agency in storytelling experiences. Since children's reading skills are very different from age to age and it is important to provide support that fits their age, we set the target age range of our potential users to be three to eight years old, including the pre-reading stage and early-reading stage (Hoien and Lundberg, 1988; Norman and Malicky, 1987). This work aims to allow children in these stages in reading development to make decisions on story elements by answering to their parents' questions and experience rewritten stories based on these interactions with their parents. Our review of the previous literature on interactive storytelling and story writing, as well as existing educational activities for story writing, led to three high-level goals that informed our design of a human-AI system for interactive story rewriting.

2.1 Provide candidate dimensions to be changed by parents and children

As a first step in teaching how to rewrite, existing activities help students learn which dimensions (e.g., point-of-view, characters, setting) a story consists of and what each dimension means. After that, students are asked to mark up the story with everything they would need to change while considering the dimensions learned (House&Museum, 2020). However, since children in the pre-reading stage cannot read and the aforementioned task might be hard for those in the early-reading stage (Hoien and Lundberg, 1988; Norman and Malicky, 1987), figuring out these dimensions would be challenging for children. Although finding all these elements would be easy for parents, they may also feel aversion to this tedious task (Lin et al., 2021). Therefore, to help parents identify the elements to change in the story, we first identified six dimensions that compose a story by referring to existing taxonomies, which range from general dimensions of stories (Adolfo et al., 2017; Carbonell, 1980) to a schema of children's story understanding (Paris and Paris, 2003). These were the identified dimensions:

- **Character**: the people in a story, primary and secondary, protagonists and antagonists.
- **Setting**: where and when a story takes place, and the interaction between those elements.
  - **Time**: time of day, date, month, year, season, and point in history—past, present, or future.
  - **Place**: town/state/region/country, geography, natural environment, built environment (roads and buildings, rooms and furnishings).
- **Description of the character**: adjectives or complements describing the character.
- **Feeling/emotion**: description of how characters feel.
- **Action**: what characters do and how they do it.

Based on these findings, our prototype provides candidate entities in the original story corresponding to each dimension to help parents notice what to change so that they can ask their children about how they want to rewrite it.

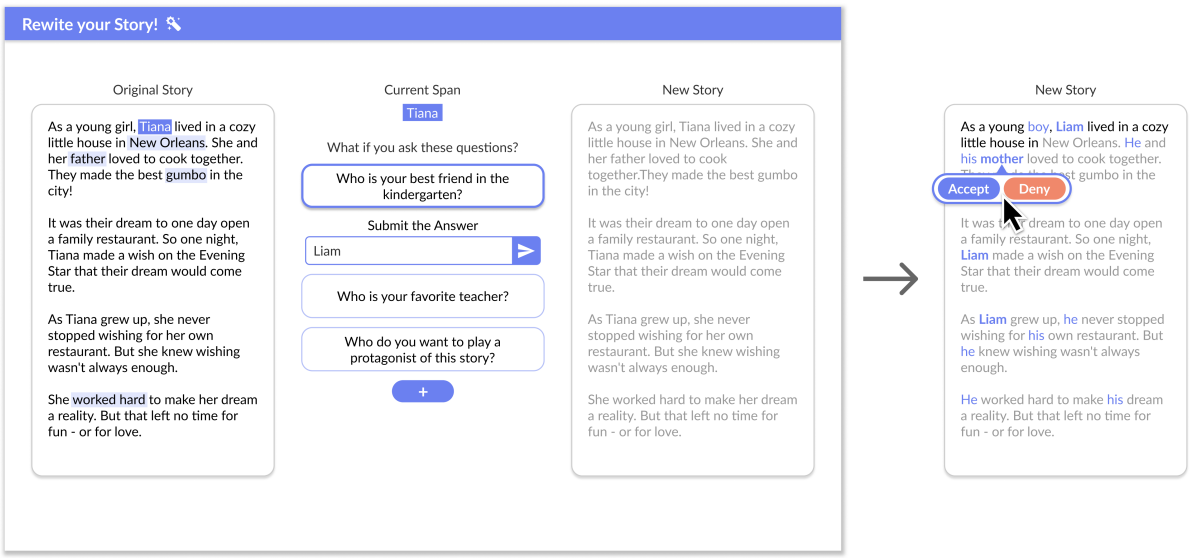

Figure 1: The design for the interactive story rewriting interface shows that (1) the parent has chosen the first question to ask their child, (2) the child answered with "Liam" as a name to replace "Tiana" (i.e., the main character's name), (3) the story has been rewritten based on this entity change, and (4) the user can accept or deny additional changes by clicking on them in the rewritten story.

2.2 Support building relationships between parents and children through question answering about how to rewrite

Rewriting activities have been designed to help students with reading and writing proficiency to rewrite stories by themselves (Calkins, 1980; House&Museum, 2020), however, children in our target age range lack proficiency in reading or writing and may need external guidance to decide on how to change chosen entities. One way to do so is for parents to explicitly ask their children questions to elicit these preferences and decisions. Moreover, dialogic reading theory (Zevenbergen and Whitehurst, 2003) emphasizes the educational benefits (e.g., language development) of parents asking questions to children during storytelling. This theory also encourages parents to ask follow-up questions that align with their child's interest (even when it is less related to the story's content) instead of simply reading all the words in the book. Therefore, we aim to support parents to ask questions about how to change the story to allow younger children to make a change in the story while also helping to build the relationship between parents and children.

2.3 Present rewritten stories based on the child's decisions

When children decide to change a story and believe that their changes will have meaningful outcomes on the story, they feel agency in the process (Riedl and Bulitko, 2013). Based on prior work, key elements towards fulfilling children's agency are autonomy and effectance (Murray, 1998; Roth and Koenitz, 2016). Thus, it is important to change the text according to the children's choices while also considering the following points. First, changing additional spans that are relevant to the entities that the children chose to change allows the children to recognize the effect of their choices. For example, if a child changes the setting from "New Orleans" to "Seoul," then changing the food "Gumbo" accordingly would make the child feel that their choices have more impact beyond just changing the name of the city. Also, changing "Gumbo" would be more meaningful for them than changing "little house", for example, due to the relevancy of these entities with the setting "New Orleans". The second point is that effectance (i.e., the effect a chosen entity has on the story) should be applied in moderation—too many automatic changes can take away opportunities for children to make their own changes. Although it depends on the child's literacy and comprehension of the story, it is important for parents to be able to control how many additional spans the system changes. Finally, if the character is changed, there could be linguistic elements like pronouns that might also have to be changed in subsequent parts of the story. Therefore, even for parents with prior story-rewriting experiences, it

can be hard to rewrite an entire story according to their children's choices as they should consider the three points described above to support children's agency.

3 System

Based on the design goals, we envision an interface that supports parent-AI-child interaction for interactive story rewriting. In this section, we describe the interface and a preliminary prompt-based pipeline that uses GPT-3 (Brown et al., 2020) to enable such an interface.

3.1 Interface

The interface, shown in Figure 1, consists of three main components: original story component (left), Q&A component (middle), and rewritten story component (right).

Through the original story component, the parent user can see the original story as well as potential spans that can be changed while reading the story. Here, spans refers to *"within-sentence phrases (up to a threshold length) in the document"* (Wadden et al., 2019). The changeable spans are highlighted and are prompted to be changed in the order that they appear in the story, with the current span to change is highlighted with more contrast. These highlights allow the parent to get an overview of what parts of the story will be changed before they start reading the story to their child. As seen from the figure, the first span to change in the story is the name of the main character, "Tiana".

To start asking their child how they would want to change the current span, the parent can refer to the Q&A component. The Q&A component presents a set of AI-generated suggested questions that the parent could ask their child to elicit answers that could be used to replace the current span. In the example, the current span is the main character's name so the suggested questions are worded such that they prompt the child to answer with names. Additionally, to help parents understand their children better and build their relationship, the suggested questions ask about the child's preferences, feelings, and/or daily lives. If they are not satisfied with the suggested questions, parents can click on the "+" button to generate more suggested questions.

From the Q&A component, the parent can select a question they like, ask it to their child, and then enter the answer that their child gave into the interface. With the answer submitted, the parent can then see how the story has been rewritten: the current span has changed to the submitted answer (e.g., "Tiana" changed to "Liam") and other parts of the story have also been changed accordingly (e.g., "girl" changed to "boy"). Rewritten parts of the story are colored to help parents notice them more easily to encourage parents to talk about them with their child. For these additional rewrites based on the change that the child requested, the parent can accept or deny them by clicking on that part of the text. Finally, the interface indicates the parts of the story that the parent can now read to their child by making them more salient.

3.2 Pipeline

As an initial step to investigate how such an interactive story rewriting system could be realized, we leveraged the few-shot capabilities of a large language model (LLM), in this case GPT-3, to develop a preliminary pipeline for the interface using prompt engineering.

3.2.1 Span extraction

Our pipeline extracts spans in the story based on a set of pre-defined dimensions in Section 2.1. As mentioned before, the dimensions were: character, setting (time and place), description of character, feeling/emotion, and action. We designed prompts to extract spans corresponding to each dimension above in the original story, as shown in Figure 2. For each sentence in the original story, the interface extracts spans to be changed.

3.2.2 Question generation

Our interface provides questions that parents can ask their child to decide how to rewrite a span. To generate these questions, we design prompts that contain pairs of spans and questions, where the questions could be answered by the span. In the case of characters, when the original span is added to the prompt as the given word ("Cinderella" in Fig. 2), the model generates questions that children can answer with names. The prompts include few-shot examples such that generated questions ask about children's preferences, daily lives, and ideas as writers of this story. For example, the pipeline provides questions like *"Who is your favorite person to play with?"*, as well as *"Who do you want to make a protagonist of this book?"*. In case of action-related questions, the generated questions ask children what they would do or what they had

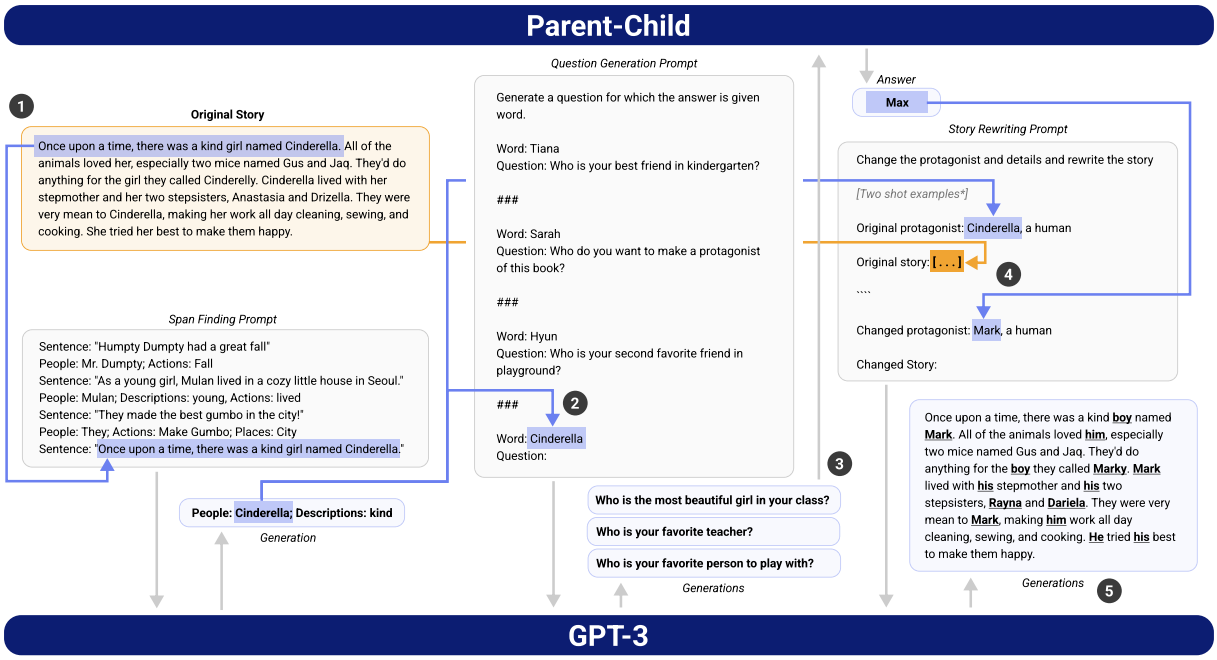

Figure 2: The prompt-based pipeline: (1) a span finding prompt is used to elicit the model to extract spans from the sentences in the original story, (2) questions are then generated with the extracted span and a question generation prompt, (3) several questions are generated which the parent can then ask their child to get an answer span, (4) the answer is combined with the original span and paragraph with the story rewriting prompt template (*full prompt template in Appendix A), and (5) the model is prompted to rewrite the paragraph (changed spans are underlined).

done in previous experiences similar to the given situation in the story.

3.2.3 Story Rewriting

To rewrite story paragraphs based on the child's decisions while keeping coherency with prior context, we designed two rules for rewriting based on our design goals in Section 2: (1) change spans according to the children's answers, (2) additionally change semantically relevant spans (e.g., pronouns, objects), (3) control how many additional changes are made to the story text by the LLM according to the parents' choices. Based on these rules, we designed two-shot examples of how to change an original story paragraph into a changed one with the relevant spans modified. A prompt is constructed with these examples, the original spans, the original story paragraph, and the changed spans (i.e., the child's answers to the parent's questions entered into the interface). This prompt is passed to the model to generate the rewritten story. We checked whether children's choices are reflected in the changed text (i.e., all instances of the original span have been changed), if not, we generate again until the choices are reflected. For the original span targeted to change (like "Cinderella" in Fig. 2), we used coreference resolution techniques (Clark and Manning, 2015) to find mentions of the same entity in the original paragraph to exclude them from spans to change so that the same entity is not asked to be changed again. To ensure coherency of the paragraph, the same technique is also used to check whether the generated text changes relevant linguistic elements, such as pronouns, appropriately based on changes in specific spans. Finally, to let parents have more control on additional changes, the system initially allows parents to accept or dismiss the additional entity changes generated by LMs. After multiple steps, the pipeline can construct a prompt with examples from previous steps: rewritten stories with additional changes that the parent accepted. With this prompt, the pipeline can generate additional changes that are more adapted to the parent and more likely to be accepted.

4 Evaluation Plan

We describe plans for evaluating our system, including the technical evaluation and human evaluation for each tasks in the pipeline, and a user study.

4.1 Plan for Technical Evaluation

In order to evaluate our entity extraction pipeline, we plan to collect a dataset that includes annotations for story-based entities allocated to each of

our dimensions and coreference clusters. These annotations will be added to the 278 fairytales in the FAIRYTALE QA dataset (Xu et al., 2022). Following the convention established in this line of work, an entity prediction is considered correct if its type label and head region match those of the gold entity (Luan et al., 2018). We can compare our pipeline with a baseline such as DyGIE++ (Wadden et al., 2019), a state-of-the-art end-to-end IE model which extracts entities and relations jointly, on our dataset.

4.2 Plan for Human Evaluation

The purpose of question generation is to ask how to change these story dimensions and to build relationships between parents and children. Therefore, based on the literature (Xu et al., 2021; Yao et al., 2021) and our goal of asking children about how to change the dimensions, we will invite experts with degrees in related fields (e.g., education) or substantial experience in parenting and dialogic reading. These experts will then be asked to score the questions generated according to the following criteria.

- **Readability**: The generated QA pair is in readable English grammar and words.
- **Question-Answer Relevancy**: How the generated question is relevant to the answer.
- **Question Diversity**: Richness and diversity in content to prompt varied dialogues between parents and children.

To assess how well the rewritten story addresses the particular change being requested, we plan to conduct human evaluation adapted from how Qin et al. (Qin et al., 2019) assessed the quality of rewritten endings in counterfactual story generation tasks. We will present crowdworkers from Amazon Mechanical Turk with one paragraph from the original story, the seed change (i.e., the initial change that determines how the story will be rewritten), and the rewritten story. Then, we will ask workers to answer the following questions on a 5-point Likert scale: (1) Does the rewritten story respect the changes induced by the seed change?, (2) Does the rewritten story keep coherence with details in the prior context of the rewritten story?, and (3) Is the plot of the rewritten story relevant to the plot of the original story? Moreover, inspired by Lee et al.'s work (Lee et al., 2022) that measured how helpful LM generations are to writers, we will also ask workers to accept or dismiss our pipeline's suggestions for additional changes, and calculate the rewriting performance by using the following metric: (the number of accepted suggestions) / (the number of total suggestions).

4.3 Plan for User Study

To explore how interactively rewriting stories through our system affects children's agency and how parents and children use our system, we plan to run a user study where participants (i.e., parent-child pairs) will use our system to interactively rewrite one story. We plan to answer the following questions through this study.

1. Could our interactive story rewriting system enhance children's agency?
2. How do parents and children interact while using our system? Can parents successfully use our system to create interactive story rewriting experiences for their children?
3. Do parents find our system usable, useful, and enjoyable?

To examine whether our system provides children with choices and allows them to tailor the story content to their own needs or preferences, we will provide a questionnaire that asks about two dimensions that determine agency: autonomy (freedom to choose from a large set of options without feeling pushed in one direction) and effectance (how meaningful children's choices are for the story progression). These questions are based on the literature (Roth and Koenitz, 2016; Kucirkova, 2022) that studied how to evaluate interactive systems designed to support children's agency. After the collaborative story rewriting activity, the children will be asked to rate their experience using the Smileyometer instrument (Read and MacFarlane, 2006), which communicates the idea of the Likert scale using smiley faces.

To understand how parents and children used our system, we plan to observe user behaviors during the user study. Our aim is to answer the following questions:

- How did the parents decide which entity to change among the potential entities recommended by the system? What kinds of entities did parents ask their children to change?

- How did parents ask questions? What kinds of questions, among the generated questions, did parents ask their children?
- How did parents read the rewritten stories?

Based on these questions, we plan to make a list of behaviors of interest, which can be objectively identified and with little room for subjective interpretation. For example, behaviors such as *asking a generated question*, *asking a question of their own*, or *asking a generated question as follow up questions* can be annotated.

We plan to ask parents to answer a post-study usability questionnaire to collect and analyze their assessment of our system, including the perceived usefulness of the key features, the perceived difficulty of use, and their willingness to use the system in their real life. We will design this questionnaire following how previous work has made questionnaires to evaluate AI-enabled task automation and creativity tools (Zhang et al., 2022; Li et al., 2019).

5 Future Work

In this work, we presented a preliminary pipeline for human-AI story rewriting that uses prompts and the few-shot capabilities of GPT-3. In future work, finding well-performing models for each subtask in the pipeline and conducting evaluation of such models are our immediate next steps. For entity extraction, we are planning to experiment with extraction methods that prior work adopted, such as leveraging QA models to extract story dimensions (Ammanabrolu et al., 2020) and extracting candidate spans through heuristics designed based on a pedagogical framework (Yao et al., 2021). In the case of question generation, it is necessary to identify more concrete types of questions that parents would need to build meaningful relationships with their children. We have a plan to conduct formative interviews and an extensive literature survey to identify them. We then plan to use LLMs to generate diverse sets of questions based on these question types. To engage children more in the parent-child interaction, asking multi-turn questions might be a better solution than asking independent questions in separate rounds (Zevenbergen and Whitehurst, 2003). Moreover, through multi-turn questions, children can be elicited for choices on multiple spans. By passing multiple span changes to the model at once, additional semantically relevant spans can be found and rewritten by considering the post context of stories. For story rewriting, although our system lets users accept or dismiss the additional entity changes generated by LMs, it is necessary to identify what people expect for how much a story should change based on seed changes. A preliminary study to identify and meet users' expectations can serve as a first step toward understanding how to rewrite stories. Moreover, rewritten stories made by a generative model could propagate and may even amplify various biases (e.g., gender, race, and culture) found in text corpora, which can cause negative outcomes like reinforcing gender stereotypes or building narrow understandings of normative behavior. As a first step to prevent this, our system can apply various NLP techniques for recognizing and mitigating biases (Sun et al., 2019) and warn users that a given generation might have a specific bias and help them deal with this bias.

Acknowledgements

This work was partly supported by the KAIST-NAVER Hypercreative AI Center.

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A Story rewriting prompt template

```
Change the protagonist and
details and rewrite the story

Original protagonist: Merida, a
human
Details:
1. cake
2. bear

Original story: Back at the
castle, Merida presented the
cake to her mother. She watched
closely as Elinor took a bite.
At first, nothing happened. But
then, Elinor began to feel sick.
Merida helped Elinor into bed.
The next thing Merida knew, a
huge, furry shape was rising
from the sheets! The Witch's cake
had turned Elinor into a bear!
Worried her mother was in danger,
Merida sneaked her out of the
castle.

````

Changed protagonist: Lucy, a dog
Details:
1. candy
2. fish

Changed story: Back at the
castle, Lucy presented the candy
to her owner. She watched closely
as Bill took a bite. At first,
nothing happened. But then, Bill
began to feel sick. Lucy helped
Bill into bed. The next thing
Lucy knew, a huge, scales shape
was rising from the sheets! The
Witch's candy had turned her
owner into a fish! Worried her
owner was in danger, Lucy sneaked
him out of the castle.

Original protagonist: Mulan, a
human
Details:
1. China
2. dog

Original story: Thousands of
years ago in ancient China, there
lived a beautiful young woman
named Mulan. She lived with her
parents and a dog named Little
Brother. Mulan's father had once
been a great warrior, but his
leg had been injured in battle.
As an only child, Mulan felt
responsible for upholding the
family honor. One day, a man
arrived with terrible news from
the Emperor. The Huns, China's
enemy, had invaded.

````

Changed protagonist: Julian, a
tiger
Details:
1. Tigerland
2. mouse

Changed story: Thousands of
years ago in ancient Tigerland,
there lived a beautiful young
tiger named Julian. It lived
with parents and a mouse named
Little Mousy. Julian's father had
once been a great warrior, but
he had been injured in Tiger-Lion
battle. As an only child, Julian
felt responsible for upholding
the family honor. One day, a
white-furred tiger arrived with
terrible news from the King tiger.
The Lions, Tigerland's enemy, had
invaded.
```