Having one's cake and eating it too: Coherence of children's emergent narratives*

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Abstract

In the emergent narrative approach to Interactive Storytelling, narratives arise from the interactions between player- or computer-controlled characters in a simulated story world. This approach offers much freedom to the players, but this freedom may come at the cost of narrative structure. In this paper we study stories created by children using a storytelling system based on the emergent narrative approach. We investigate how coherent these stories actually are and which types of character actions contribute the most to story coherence, defined in terms of the causal connectedness of story elements. We find that although the children do produce goal-directed story lines, overall the stories are only partially coherent. This can be explained by the improvisational nature of the children's storytelling with our system, where the interactive experience of the players is more important than the production of a coherent narrative. We also observe that the communication between the children, external to the system, plays an important role in establishing coherence of the created stories.

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1 Introduction

Stories are more than just temporal sequences of events. A coherent narrative must have a causal structure, with the story events being causally connected and related to some overarching goal that 'glues' them together [10]. According to Trabasso's influential model of story understanding, coherent stories consist of hierarchies of goals, actions and outcomes [19]. In this paper we use a variation of this model to investigate the coherence of children's stories that were created using an interactive storytelling system.

The *Interactive Storyteller* [1, 2] is a system for interactive digital storytelling that allows users to control the actions of one or more characters in a simulated story world, where they interact with characters controlled by intelligent agents. Stories emerge from the actions of the player- and computer-controlled characters; no part of the storyline is scripted in

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advance. This approach is called *emergent narrative* [4]. Emergent narrative allows players a lot of freedom in shaping the story they take part in. However, a potential drawback of this approach is that when players can do (more or less) whatever they like within the story world, without any narrative structure being imposed on them, the resulting stories may not exhibit much coherence. This trade-off between narrative structure and player freedom in interactive storytelling is called the narrative paradox [8].

In this paper we study the coherence of children's stories created with the Interactive Storyteller. In this system, narrative is fully emergent; the human users are only constrained in their actions by the limitations of the implemented story world. For example, certain actions can only be carried out on certain locations or after other actions have been carried out. Some of the available actions lend themselves well for the creation of coherent storylines, while others do not. Thus, the Interactive Storyteller enables, but does not force, the creation of coherent stories. It is hypothesised that players, when given the opportunity by the emergent narrative system, will be motivated not only by acting out their character roles, but also by seeking out narrative coherence, i.e., perform actions that contribute to the story as a whole [16].

Our two main questions are: (1) To what extent do children playing with the Interactive Storyteller spontaneously create coherent storylines? (2) Which of their selected actions contribute to coherence, in terms of logical connections between story elements, and which do not? By answering these questions, we try to shed some light on the issue to what extent emergent narrative can achieve not only player freedom but also narrative coherence. We also hope to gain some preliminary insights into which types of actions may help to optimise both player experience and narrative structure in emergent narrative systems.

We let four pairs of children play with the system and analysed the stories they produced, determining their coherence by looking at the story components selected by the children and the extent to which these components were causally connected. We included the children's system-external communication in the analysis, because our approach to interactive storytelling is closely related to children's improvised dramatic play, a narrative activity in which metacommunication plays a very important role [14].

First we briefly discuss related work (Section 2) and describe the Interactive Storyteller (Section 3). Then we describe the set-up of the experiment (Section 4) and present our story analysis (Section 5). We end with a discussion and conclusions (Sections 6 and 7).

2 Related work

Children's narratives have been the subject of many studies in the field of cognitive psychology, investigating the influence on narrative coherence of factors such as children's age. In most of these studies, data were gathered by having children narrate the events shown in picture sequences [15, 20] or (more rarely) other media such as TV shows [9]. Our work is inspired by these studies, in that we use similar methods to determine coherence. However, instead of studying narrations of given event sequences, we look at stories created by children using an interactive storytelling system.

In the past, several interactive storytelling systems aimed at children have been developed. FearNot! [5] is an educational system in which intelligent virtual characters autonomously act out bullying scenarios, with the children giving advice to the victim. Teatrix [12] is a tool for the development of narrative competence through collaborative story creation. Children can take on the role of a character and interact with computer-controlled characters in a virtual environment to create stories. Ghostwriter [13] is a virtual role-playing environment for children, who interact with one computer-controlled character and two characters controlled by a human role-play leader. Like the Interactive Storyteller, these systems all take an emergent narrative approach and support children's story improvisation through roleplay in interaction with virtual characters. However, except for an analysis of the GhostWriter role play logs for indications of characters' personalities and moods [13], we have found no analyses of the stories that have been created with these (or other) interactive storytelling systems.

Storytelling systems with tabletop interfaces, like the Interactive Storyteller, include Reactoon [3], TellTable [7] and StoryTable [21]. These aim at facilitating storytelling by children and do not incorporate intelligent agents as characters in the story. In most cases, there appears to have been no evaluation of the stories created with these systems, with the exception of the StoryTable system. A comparison of stories created with or without the StoryTable revealed no significant differences in structure and cohesion [21].

3 The Interactive Storyteller

The Interactive Storyteller is a system for interactive digital storytelling with a multi-user tabletop interface. It was built on the basis of the Virtual Storyteller (VST), a multi-agent system for story generation in which intelligent agents act out the role of characters in the story [16, 17, 18]. Before describing the Interactive Storyteller and the story domain used for our experiment, we first provide a brief explanation of the underlying VST system.

Story generation in the VST happens in two phases: simulation followed by presentation. In the simulation phase, autonomous agents play the role of characters in the story world. They pursue goals, reason about their perceptions, experience emotions and take actions in the world. The resulting event sequence is captured in a formal representation called the *fabula*, which is based on the causal network model of Trabasso et al. [19]. The fabula model defines causal relationships between story elements such as goals, actions, beliefs and emotions. In the presentation phase, a narrative is generated based on a fabula representation of all that transpired in the story world. This narrative is a fluent text in which discourse markers (*because, so, then, ...*) are used to express the causal relations between the story elements. See [17] for more details on the fabula model and how it can be used to generate cohesive narrative texts.

One of the story domains that has been created for the VST is loosely based on the "Little Red Riding Hood" (LRRH) fairy tale [18]. The LRRH story world contains three characters: Little Red Riding Hood (Red), Grandmother (Granny), and the wolf (Wolf). It has five locations: Red's house, Granny's house, the clearing in the forest, the beach, and the lake. Possible character actions in the LRRH domain include moving between locations, talking to other characters, baking, eating and poisoning cakes, and location-specific actions such as diving into the lake. This is the domain we used in the Interactive Storyteller.

Whereas in the VST, stories are generated by intelligent agents without human intervention, in the Interactive Storyteller human users can control the actions of one or more characters through a graphical interface. For each character, control can be switched between an autonomous agent and a human user. The story world is represented visually on a multi-touch table, using a top-down map view, as shown in Figure 1. To prevent one side of the table from being optimal for perceiving the story world, characters are displayed in one direction and houses are projected the other way. The locations in the story domain are marked by blue circles on the map. The map also shows the paths between the locations, which need to be followed by the characters. For example, a character cannot go directly

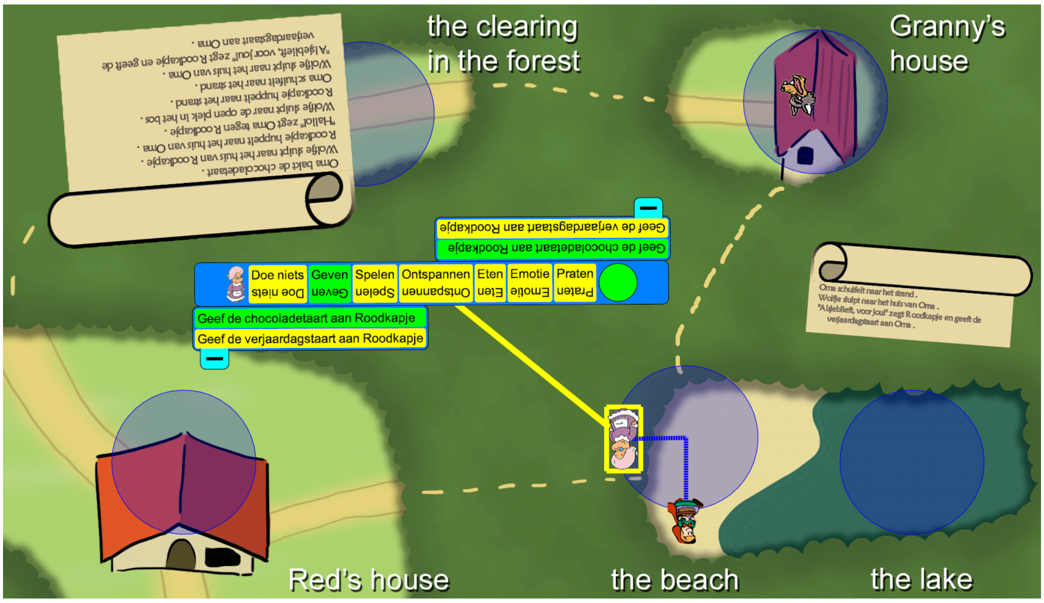

Figure 1 The interface of the Interactive Storyteller (touch-only version). Location names have been added for the reader's benefit.

from Red's house to Granny's house, but only via the beach or the clearing in the forest.

Users can change the locations of characters by moving physical toys that represent the story characters across the surface of the multi-touch table, from one location to the next. The use of these tangibles is optional; we also developed a touch-only version of the interface where graphical representations of the characters can be moved around by dragging them across the table surface. Figure 1 shows the touch-only version of the interface. The tangible interface is the same, except that the characters are not represented by images but by physical objects, as shown in Figure 2 below.

There is a menu for the selection of non-move actions by users, shown in the centre of Figure 1. Actions are carried out in a turn-based fashion. When a character gets the turn, the system determines which actions are possible for that character given the current state of the story world, and displays them in the menu. To allow an equal view from all sides of the table, the menu is presented in two directions.

When a character performs an action, this action is expressed using a simple sentence and narrated using Loquendo text-to-speech. As we found in pilot tests with the Interactive Storyteller, the spoken narration provides valuable feedback to the children. The narrations are also displayed in the two scrolls that can be seen in Figure 1 (one for each side of the table). These scrolls serve as a time-independent source of information about what has happened in the story so far. For more details on the interface and the design motivations of the Interactive Storyteller, see [1, 2].

4 Experiment

In a small-scale user experiment, we let four pairs of 8–11 year old children play with the Interactive Storyteller. All participants were pairs of siblings or friends; see Table 1. One child controlled the character Red; the other controlled Granny. Wolf was always computer-controlled.

Table 1 The four pairs of participants in our user experiment.

	Participants (age)	Relationship	Session 1	Session 2
Pair 1:	female (9) + male (9)	friends	touch-only	tangibles
Pair 2:	female (10) + male (8)	siblings	tangibles	touch-only
Pair 3:	male (8) + male (10)	siblings	touch-only	tangibles
Pair 4:	female (10) + female (11)	friends	tangibles	touch-only

Figure 2 Children playing with the Interactive Storyteller (tangible version).

The experiment was originally set up to test, among other things, whether the use of tangibles in our system setup is preferred over a touch-only approach. Therefore, each pair of children carried out two play sessions, one with and one without tangibles (in a counterbalanced order). The results of this comparison are reported in another paper [2]; here we only focus on the stories that were created by the children during the experiment. Because system version (tangible or touch-only) appeared to have no influence on the stories that were created, we ignore this factor in the remainder of this paper.

At the start of each run of the experiment, the children were told that they could use the system to create a story, and the basics of the user interface were explained to them. Because we were interested in their spontaneous behaviour while interacting with the system, we did not give them a specific goal to achieve, nor did we ask them to talk or think aloud. The entire experiment was recorded on video; see Figure 2. On average, the play sessions lasted 12 minutes (min. 9, max. 14 minutes). All story actions taken through the Interactive Storyteller interface were logged, and the children's communication during the play sessions was transcribed.

5 Story analysis

In this section we analyse the stories generated in the experiment to see to what extent the children made use of the possibilities to create coherent stories offered by the Interactive Storyteller. Figure 3 shows excerpts of two of the stories that were created. The fragments

Story fragment 1 (Pair 4, session 1)
1. [At Granny's house] Granny bakes the cheese cake.
2. Wolf sneaks to Red's house. [From the clearing in the forest]
3. [At Red's house] "Hello," Red says to Wolf.
4. With a little bit of cyanide, Granny poisons the cheese cake.
5. "Hello back to you," Wolf says to Red.
6. Red does the dishes.
7. Granny shuffles to the beach.
8. "Give me that!" says Wolf and takes the birthday cake from Red.
9. "Give that back, it is mine!" says Red, and takes the birthday cake back from Wolf.
10. Granny shuffles to Red's house.
11. "Give that back!" says Wolf and takes the birthday cake back from Red.
12. "Oh Granny," says Red, "Wolf stole the birthday cake from me!"
13. "Oh, I feel sorry for you," Granny says to Red.
14. Wolf eats the birthday cake.
15. "This is for you," says Granny, and gives the cheese cake to Wolf.
16. Red bursts out laughing.

Story fragment 2 (Pair 1, session 2)
1. [At the lake] Red treads water for one minute.
2. [At the lake] Granny farts under water.
3. Red skips to the beach.
4. Granny bursts out in tears.
5. [At the lake] Wolf gets pretty hungry.
6. Red skips to Red's house.
7. Granny shuffles to the beach.
8. Red is angry at Granny.
9. Granny shuffles to Granny's house.
10. Red skips to the clearing in the forest.

Figure 3 Two fragments of stories created by the children in our experiment.

are shown as they were narrated in the story scrolls,[1] with each line describing the action of a character, controlled either by the children (playing the roles of Red and Granny) or an autonomous agent (Wolf). For convenience, we have numbered the lines and added information about the characters' initial locations between brackets. Because the actions are described one by one as they happen during the interaction, the narrations are not very fluent, unlike the fabula-based narratives that could be generated by the VST after simulation is finished. However, in our story analysis we focus on the created story content and not how it is narrated. We look at the coherence of the stories from three different angles: the type of story components selected by the children (Section 5.1), the causal connectedness of these components (Section 5.2) and the coherence from the children's perspective, based on the transcripts of their communication (Section 5.3).

5.1 Story components

First, we analyse the stories created by the children in terms of their components: the character actions the children selected during their interactive storytelling sessions, as captured in the system logs.

[1] The texts are translated from Dutch.

Previous studies of story coherence have looked at the presence of narrative components such as setting information, character descriptions, actions, dialogue, internal responses, obstacles and repairs [9, 15]. Of these component types, only three are available for selection by the players in the Interactive Storyteller: dialogue, internal responses (i.e., emotions), and physical actions. Setting and character information is given by the system at the start of each session: *"Once upon a time, there was a little girl wearing a little red riding hood. She wanted to bring a birthday cake to her grandmother... "*. Note that although this introductory text mentions the goal of the character Red, the human player controlling Red is not in any way forced to act on this goal.[2] Players can set their own goals, but these cannot be passed on to the system. As a consequence, our story logs contain no goal information.

For our current analysis we divide the action component into different subtypes. Inspired by Trabasso's distinction between causal chain and dead-end events [19], we distinguish three types of actions: causal chain actions, dead-end actions, and move actions. In Trabasso's causal network model of stories, causal chain events are causally connected to other events in a goal-action-outcome sequence, while dead-end events have no follow-up and do not lead to goal satisfaction or failure [19]. Note that where Trabasso's division between causal chain and dead-end events is based on a causal network analysis of actual stories, our action type classification is an *a priori* one, based on our estimation of the likelihood that actions of a certain type will be causally connected to other actions. It does not tell us whether the actions will actually end up as part of a causal chain or a dead ends in a story. We see move actions as a third, separate action type, because it is difficult to predict the likelihood of moves being part of a causal chain or not. Move actions can go either way, and in that respect they are somewhere in between causal chain and dead-end actions.

Summarising, we distinguish five types of story components that can be selected by the children: causal chain actions, dead-end actions, move actions, dialogue and emotions. We describe these types in more detail below, after which we report on how often the children used them in their stories.

- *Causal chain actions* such as baking and giving away cakes have the strongest potential for creating coherent stories. They establish the preconditions for other actions to be performed, and thus may be part of goal-directed action sequences: characters can plan a series of such actions to try to achieve some goal. For example, a plan to poison Wolf might involve first baking a cake, then poisoning it with cyanide, and finally giving it to Wolf (expecting him to eat it). Each action in such a sequence is a prerequisite for the next.
- *Dead-end actions* are the opposite of causal chain actions in that they have the least potential for contributing to story coherence. These are actions such as watching birds or diving into the lake, which (at least in our implementation) do not change the story world and thus cannot serve as prerequisites for any other actions: no new actions become available after a dead-end action has been carried out. This makes these actions dead ends by definition.
- *Move actions* may or may not be causally connected to other actions. They may be carried out more or less at random, as we see in Fragment 2, where Red is skipping around without any clear in-story purpose. But they can also be used to establish preconditions for other actions. For example, a character can only give a cake to another character if

[2] In fact, there was only one story in which Red actually gave the birthday cake to Granny, who ate it. In most other stories the cake was either eaten by Wolf or by Red herself.

Table 2 Story components in the LRRH domain. The last column shows how often each type was used by the children in the experiment. The actions of Wolf, the computer-controlled character, are not included.

Component type	LRRH actions	#	Freq.
Causal chain action	Bake(Cake), Poison(Cake), GiveTo(Cake,Character), TakeFrom(Cake,Character), Eat(Cake)	71	20%
Dead-end action	WashDishes, DustCabinet, DiveIntoLake, TreadWater, FartUnderWater, EnjoyTheSun, RollInSand, TakeNap, BuildSandCastle, WatchBirds, WatchClouds, LeaveAlone(Character)	71	20%
Move action	MoveFromTo(CurrentLocation,NewLocation)	111	32%
Emotion	Laugh, Cry, BeAngryAt(Character)	67	20%
Dialogue	Greet(Character), TellAboutCakeTaken(Character), ExpressSympathyFor(Character), Thank(Character) AskWhatToDo(Character), TellAboutPlan(Character)	27	8%
Total		347	100%

both are at the same location, and to achieve this, a sequence of move actions may be necessary. We see this in Fragment 1, where Granny goes to Red's house via the beach as part of her plan to poison Wolf, who is at Red's house.

- *Emotions* in the LRRH domain are limited to anger, happiness (expressed through laughter) and sadness (expressed through crying). They can be causally connected to other actions in two ways. First, emotions can cause goals to be adopted; for example, being angry at Wolf may cause Red or Granny to adopt the goal of poisoning him. Second, emotions may be internal responses to story events; for example, Red laughing when Wolf is given the poisoned cake in Fragment 1.
- *Dialogue* includes actions such as characters greeting each other or telling each other about events in the story world. One dialogue action often triggers another, leading to brief exchanges like the one in Fragment 1, where Red complains to Granny about Wolf having taken her cake, and Granny reacts by expressing her sympathy. The boundaries between dialogue and emotion are not very clear-cut: expressing sympathy through dialogue could also be seen as an indication of emotion (feeling sorry for the other), and the same could be said of saying thanks as an indication of gratefulness. However, we feel the dialogue aspect is more prominent in these cases.[3]

Based on the system logs from the experiment, we determined the frequency with which the different story components were included by the children in the stories they created. Table 2 shows the results.

In total, the children carried out 347 character actions over all play sessions; an average of 43 actions per play session. Not included in this count are the actions by Wolf, the computer-controlled character. Wolf carried out 69 actions over all sessions, which amounts to only 17% of all character actions. The reason for this relatively low percentage is that Wolf only carried out goal-directed actions (in his case, chasing after cakes to eat) and frequently skipped a turn when unable to make a plan to achieve his goal of eating cake.[4]

[3] As can be seen in Fragment 1, some character dialogue is included in the narration of GiveTo and TakeFrom actions. However, these actions are not presented as dialogue actions to the players; the dialogue is only added to spice up the narration.

[4] In the LRRH domain only Granny and Red can bake cakes, so Wolf could not bake his own.

Looking at the actions selected by the children, we see that causal chain actions are just as frequent as dead-ends. This is remarkable, because in the LRRH world causal chain events can only be selected when certain preconditions are met. For example, poisoning and giving away a cake is only possible if it has been baked first, and baking a cake can only be done at Granny's house. In contrast, the other four locations all had at least two dead-end actions available with no other restrictions than the character being at one of those locations. The fact that the children did not carry out more dead-end actions, suggests they may have had a preference for actions that were more likely to be part of a causal chain. However, as noted above, the causal chain potential of the selected actions need not have been fulfilled in the stories that were produced: without follow-up, a causal chain action would be a dead end in practice. In other words, only looking at the presence of story components is not a sufficient indication of coherence; we also need to look at their causal connectedness in the story [9].

5.2 Causal connectedness

To see whether the selected story components were really part of causal chains or not, we examined the causal relations between them. To this end we looked at the stories produced by the children (as shown in Figure 3), and used common sense reasoning to find logical connections between the story components.[5] To count as causally connected, story components either had to be part of a goal-directed causal chain in the sense of Trabasso et al. [19], thus providing global coherence, or be connected to an immediate cause or consequence, thus providing local coherence [20]. Simple enablement relations (e.g., a move to some location enabling a character to do something at that location) were only counted if they were clearly part of a plan. Unlike [9], in our analysis we did not limit ourselves to determining causal relationships between adjacent story components. In the Interactive Storyteller, characters take turns to carry out actions in the story world. This means that in the narration, components of an individual character's plan are usually not adjacent but intersected by other characters' actions.

As an illustration, consider the two story fragments in Figure 3. Fragment 1 holds a clear example of a goal-action-outcome sequence with Granny carrying out a plan to poison Wolf, baking a cheese cake as the first step (1), poisoning it (4), and going to Wolf (7, 10) to give it to him (15).[6] Red, meanwhile, carries out more locally connected actions: she reacts to Wolf's arrival at her house by greeting him (3), and to his repeatedly taking her birthday cake, the first time by taking it back (9) and the second time by complaining to Granny (12). In her turn, Granny briefly interrupts her poisoning mission to commiserate with Red (13). Finally, Red reacts with laughter (15) to Granny giving the poisoned cake to Wolf. Overall, Fragment 1 is quite coherent. The only action that is not causally connected is Red doing the dishes (6), a dead-end action with no apparent cause or purpose within the story. Fragment 2, on the other hand, is incoherent: the characters seem to be carrying out actions at random, and when they display emotions it is not clear what these are in response to.

All stories produced in the experiment were annotated by two of the authors, who determined for each character action, dialogue or emotion whether it was coherent (i.e., causally connected to another story component) or not. Annotation took place in three

[5] The VST, the non-interactive version of our system, logs all causal connections between character actions in the fabula model. However, in the Interactive Storyteller these causal connections are only recorded for computer-controlled characters. For player-controlled characters, the system only records which actions they took, because it has no knowledge of their plans and motivations.

[6] The eventual outcome, Wolf eating the poisoned cake, is not included in the excerpt.

rounds. In the first round, half of the stories were annotated by both annotators. The interannotator agreement for this first round was fairly low (Cohen's κ 0.60). After discussing and finetuning our definition of connectedness, the remaining stories were annotated, this time achieving a satisfactory level of agreement (Cohen's κ 0.73). Finally, in the third round all differences between the annotators were resolved by discussion. The results are given in Tables 3 and 4.

Table 3 shows per story component type how many instances of that type were causally connected to some other component, or not. It also shows how many story components were causally connected overall, regardless of their type. Taking together all components of all stories, 40% of these components were causally connected (i.e., coherent) while 60% were not. Table 4 shows the proportion of all connected or disconnected story components that belonged to each of the component types, thus showing the relative contribution of all types to the overall coherence of the created stories.[7]

Table 3 Causal connectedness of story components per type.

Component type	Causally connected	Not causally connected
Causal chain action	75%	25%
Dead-end action	3%	97%
Move action	32%	68%
Emotion	34%	66%
Dialogue	93%	7%
All types	40%	60%

Table 4 Contribution to story coherence of each component type.

	Causal chain	Dead-end	Move	Emotion	Dialogue
Coherence	38%	1%	25%	17%	18%
Incoherence	9%	33%	36%	21%	1%

Unsurprisingly, most causal chain actions turned out to be causally connected, and causal chain actions contributed the most to story coherence, with the opposite holding for dead-end actions. We found two dead-end actions that actually seemed to have a causal connection to another story component: one was Granny rolling in the sand at the beach, triggering an emotional response by Red (laughing), and the other was Red leaving Wolf alone after having given him a cake to eat. Only 36% of the move actions turned out to be causally connected, either because they were part of a plan or because they triggered an immediate reaction such as a greeting. Due to their frequency, moves still provided the second largest contribution to story coherence. Across all stories, we counted 18 goal plans, i.e., goal-directed action sequences. These causal chains had an average length of four story components.

Of the emotions, only 34% were annotated as being causally connected, usually because they were clearly a response to another story component. In contrast, dialogue connectedness was 93%. Dialogue thus provided a relatively large contribution to story coherence in spite of being the least frequently selected component type. The most frequent dialogue actions

[7] Due to rounding, the percentages for coherence in Table 4 do not add up to 100%.

were exchanges of greetings, which (similar to emotions) provided local rather than global coherence.

A mixed picture emerges from this analysis. On the one hand, a large portion of the created stories was found to be coherent (in terms of the number of causally connected components), displaying both global and local coherence. On the other hand, an even larger portion of the stories was incoherent, consisting of seemingly unconnected story components. However, this analysis presents a somewhat misleading image of the stories' coherence, because not all that makes the stories coherent has been captured in the logs of the Interactive Storyteller. Specifically, what is missing are the verbal and nonverbal contributions the children made to the story while they were interacting with the system and with each other. We address these in the next section.

5.3 Children's communication

The emergent narrative approach to interactive stoytelling is closely related to improvisation and children's dramatic play. As argued by Sawyer [14], transforming an improvisation into a fixed text removes its most essential aspect, which is that it is a social, collaborative process, in the form of a dialogue between the players. Therefore, it is important not to overlook the children's communication when analysing the stories they created.

In the Interactive Storyteller, what happens in the story world is automatically narrated through synthetic speech and shown in the graphical interface. Thus, in principle, stories can be created without any spoken communication between the human players. In practice, we found that most of the children did spontaneously communicate with each other during the experiment, thereby adding an extra layer to the emergent story. We inspected the transcripts of children's communication to get some insight in their goals and motivations for selecting certain story components. Because many of the selected actions went undiscussed by the children (with one pair of children being too shy to say much at all), the following observations are anecdotal in nature.

First, we examined the communication transcripts to see if they provided any evidence for or against the in-story goals and motivations we had inferred as part of our story analysis in Section 5.2. For certain character actions, this inspection revealed external (out-of-story) motivations or unexpected in-story motivations were revealed. For example, one child announced *"I am going to bake, that is fun!"* indicating that this causal chain action was not initially selected as part of a plan, while another child explained *"I am giving the* [poisoned] *chocolate cake to Wolf. He didn't say anything, so I had to poison him."* Other examples are the following exchanges:

(1) **Pair 2, session 2**
Action (by Child 1): Red eats the birthday cake.
Child 2: *Actually, Red should have given the birthday cake to Granny.*
Child 1: *I already ate it. Otherwise the wolf would have eaten it.*

(2) **Pair 1, session 2**
Action (by Child 2): Granny bakes the cheese cake.
Child 2 (in character): *"Especially for you, Red."*

Not all goals mentioned by the children were actually followed up by actions. An example is a child (controlling Red) exclaiming *"I want to kill Granny"* after having been angered by the child playing Granny. However, after an alternative proposal by the other child, it was jointly decided to poison Wolf instead.

The presence of goal plans was often revealed through the children discussing what to do next. Examples are the following.

(3) **Pair 3, session 2**
Child 1: *Bake another cake.*
Child 2: *That can only be done in Granny's house.*
Action (by Child 2): Granny shuffles to Granny's house.

(4) **Pair 4, session 2**
Action (by Wolf): "Hello!" Wolf says to Red.
Child 1: *You have to give him the cake!*
Child 2: *It has to be poisoned first.*
Child 1: *(...) I will do that, alright?*
Child 2: *OK.*

(5) **Pair 1, session 1**
Action (by Child 2): Granny poisons the chocolate cake.
Child 1: *I am going to tell Wolf that you took my chocolate cake!*
Child 2: *No, I am poisoning it.*
Child 1: *Yes, but then I'll give it to Wolf.*

When the children explicitly mentioned making plans for the next actions of their characters, this usually happened late in the first interaction session, or in the second, after the children had gained some insight in the available actions in the story world and the causal connections between them. Overall, it seems that many causal chain actions were initially selected just like all other actions, as part of an exploration of the story world, to see what would happen, or simply because they were thought to be 'fun'. However, most children quickly discovered that these actions could be used to achieve goals such as giving away cakes and poisoning other characters (usually Wolf, but sometimes also their playmate's character), and then they invariably started making plans to do so. Those plans were sometimes abandoned prematurely, or the causal chains were disrupted by other actions, for example if the children were distracted from their plan by location-specific dead-end actions. The children did not appear to perceive this as incoherent. In line with Sawyer's observations of children's dramatic role play [14], they were caught up in the moment-to-moment contingency of the improvisation process and did not seem overly concerned with the global coherence of the emerging story. This is similar to adult role players, who focus on a local rather than a global story level [8]. We noted one possible exception, where the children did not want to end their play session until Wolf had eaten the cake they had poisoned for him. However, it seems likely that these children simply wanted to see the achievement of their goal, and did not consciously aim for narrative closure.

The children's dialogue also showed that several actions that seemed incoherent within the story narration were not incoherent at all in the context of the improvisation. For example, it turns out that Granny's crying in Fragment 2 of Figure 3 did in fact have a causal connection with the preceding action (Red skipping to the beach), as the child controlling Granny provided the in-character motivation *"Because you are leaving me!"*. Another seemingly incoherent emotion in the same fragment is Red getting angry at Granny for no clear reason. Inspection of the children's communication transcripts revealed that Red's emotion was actually a reaction to an event outside the story:

(6) **Pair 1, session 2**
Child 2 (holding tangibles up to camera): *Isn't this a nice Granny? Isn't this an ugly Red Riding Hood?*
Action (by Child 1): Red is angry at Granny.

Another example of a child providing a motivation for a seemingly incoherent emotion is the following:

(7) **Pair 3, session 2**
Action (by Child 2): Granny bakes the cheese cake.
Action (by Child 1): Red bursts out in tears.
Child 1: *Why can't I bake the cake?*

In this fragment it is not entirely clear whether the child was speaking in character or out of character, but it was most probably the latter. This means that like in example (6), Child 1 used the character to express his own emotion. These examples show that the children did not always distinguish between what was part of the "story proper" and what was not; they were busy playing, not story-making.

Through their play communication, the children did not only motivate and negotiate the character actions, but also enriched the emerging story in various ways. In a few cases, instead of selecting dialogue actions for their characters through the system, the children carried out the character dialogue in person, for example thanking the other or expressing sympathy for the loss of a cake. The fact that dialogue could be more easily expressed via direct communication than via the system may explain the relatively low frequency of dialogue among the story components.

In most cases, the children's play-acting did not replace the system's narrations, but augmented them. The children frequently played out what happened in the story world, expressing their character's emotions through sounds and facial expressions, and miming character actions such as shuffling, diving and eating, often while repeating the system's narrations. In other cases, the children brought in new elements that were outside the possibilities of the system. They added their own narrations (*"Much later... Wolf is still trying to think of a plan"*), expressed character emotions that were not available in the system (*"Ooh, I'm scared!"*), invented imaginary props (a cake-mold to bake a cake), and even made up entirely new actions (Red kicking Granny out of the water at the lake).

The observations we have presented in this section show that the actions that were logged and narrated by the Interactive Storyteller do not tell the whole story. The children's communication is an integral part of the improvised narratives, supplying causal connections that may not be obvious at first sight, and enriching the story in various ways.

6 Discussion

When looking at the components of the stories created in our experiment, we see that the children used more actions that had a strong potential for being causally connected ('causal chain actions'), and fewer actions with little such potential ('dead-end actions') than might have been expected based on the availability of these action types. Inspection of the causal links between these components, as inferred from the narrations, showed that 40% of all story components were causally connected. Moreover, when seen in the context of the children's play most stories turned out to be more coherent than they seemed to be when judging only from what was logged by the system. The children's system-external communication confirmed that they were acting in a goal-directed fashion at least part of the time.

At the same time, it is clear that the children did not use all available opportunities for achieving story coherence, in the sense of maximising the causal connections between the story events. Unlike the computer-controlled character Wolf, they did not always plan ahead, and if they did, they did not always follow through with their plans, allowing causal chains to be disrupted by unrelated actions. One possible reason for this is that at first, the children were not yet aware of all available actions and their effects. They only gradually discovered the things they could do within the story world, and this prevented them from exploiting all opportunities for goal-directed action right away. Our data support this explanation: 4 goal plans were carried out in the first play sessions, against 14 in the second. The proportion of causally connected story components was 36% for the first sessions, and 43% for the second.

Another possible reason for the suboptimal coherence was that, although the children had been told they could use the system to create stories, they had not been given the explicit goal to do so. Especially in the first sessions, much of the time the children were simply exploring the story world and trying out different actions without any concern for creating a coherent narrative. In general, the children's story making was done in a moment-to-moment fashion, with the children reacting to each other's and Wolf's actions as they happened and thus achieving local rather than global coherence. According to Sawyer [14], this is typical for children's dramatic role play: children who are engaged in such play do not attempt to create an overall coherent narrative, but instead react to each other turn by turn, which leads to 'pockets of local coherence' rather than global coherence in Trabasso's sense.

Overall, the children in our experiment were not overtly concerned with producing coherent narratives. Nevertheless, they spontaneously carried out many character actions that led to narrative coherence. Their motivation for creating globally coherent action sequences may have been simply that they thought (for example) poisoning another character would be a fun thing to do. In these cases, the players' goal of having a satisfying experience happened to coincide with the requirements of a coherent narrative.

Similar to role play, in emergent narrative the process (the players' experience) is more important than the outcome (the resulting story as seen from an observer's perspective) [8]. To support this process, all kinds of actions are needed. Causal chain actions allow the players to achieve goals; emotions and dialogue allow them to express themselves and communicate with computer-controlled characters; and dead-end actions can simply provide fun things to do in the story world. From our small-scale experiment, we cannot draw any strong conclusions as to which actions are most important to achieve both player satisfaction and story coherence. However, we suspect that providing more causal chain actions, as suggested by [18], may be most beneficial for this purpose, as it will allow the users to have a major influence on the course of the story (global agency, [11]), and thus presumably increase their enjoyment. As a 'side-effect', the generated narratives will also be more coherent.

To test this hypothesis, larger and more focused user experiments will be necessary. In such experiments, the players should first be given the opportunity to thoroughly explore the story world and acquaint themselves with the system, to make sure that any lack of coherence in the created stories cannot be attributed to the players' lack of awareness of the possibilities. In addition, it might be useful if the players could not only select character actions but also character goals through the system's interface. Finally, the players could be asked to think aloud to provide more insight in their reasoning and motivations than could be gained from their spontaneous communication. A drawback of such an instruction is that it is likely to interfere with the children's improvisation. The alternative 'talk aloud' approach (where children are instructed to talk about what they are doing instead of what they are thinking, [6]) is supposed to be easier for children, but may still suffer the same problem.

On the other hand, unintrusive methods such as retrospection and post-task interviews are expected to be less informative.

Future experiments should be carried out not only with children, but also with adult players, using an appropriate story domain. Previous studies have shown that at age 8, children “seem to be on the verge of a more sophisticated understanding of goals” [10, p. 327] and at age 9, they perform at a similar level as adults with regard to narrating stories in terms of goal plans [20]. Given their age group, the children who participated in our experiment should therefore have been capable of generating equally coherent stories as adults. However, children tend to be more playful and have a shorter attention span than adults, and this may have influenced the results. Although we cannot generalise our current findings to adults, we do expect that adult players will have similar preferences as children in regard to story component types and goal-directed planning.

7 Conclusion

The emergent narrative approach to interactive storytelling offers the players much freedom, but this comes at the potential expense of narrative structure. To investigate the extent of this trade-off (also called the narrative paradox), we analysed the stories created by children using an emergent narrative system. We determined the coherence of these stories, defined in terms of the causal connectedness of their components, and examined which types of character actions contributed the most to story coherence.

We found that the stories created by the children exhibited both global coherence, in the form of goal-action-outcome sequences [19] and local coherence in the form of immediate responses to other character’s actions [14]. We also observed that the communication between the children, external to the system, played an important role in establishing coherence of the created stories. However, the children’s stories were only partially coherent. This can be explained by the improvisational nature of emergent narrative, where the interactive experience of the players is more important than the production of a coherent narrative. Given that the children in our experiment spontaneously selected relatively many actions that had a strong potential for being causally connected, and used them to create goal plans, we surmise that focusing on such actions in the creation of story worlds for emergent narrative may improve both the players’ experience and the coherence of the created stories (cf. [18]).

Returning to the narrative paradox, what it basically says is that in interactive storytelling, one cannot have one’s cake (maximise the player’s influence on the story) and eat it too (have a good narrative structure). However, the results of our study suggest that when taking an emergent narrative approach, it is possible to have the cake and eat a large piece of it too.

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