

Telling Tales:

A new way to encourage written literacy through oral language

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Submitted to the Program in Media Arts and Sciences,
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Abstract

This thesis presents a new approach and a new interface to let children practice written literacy skills using oral language. Specifically, I argue that language composition is learned by practicing a set of cognitive skills that are independent of the medium in which the linguistic meaning is represented. Furthermore, I claim that tangible, technology-enhanced toys with specific features can support the development of these skills through open-ended language play. To investigate this claim, I developed a new model of composition, called the TellTale Composition Model, to address aspects of both oral and written language. This model supports the following features of children's language play: voice; structure; reference; reflection and revision; and sharing and discussion.

A new toy, called TellTale, was built to support this composition model. Three studies were conducted to evaluate both its usability and the model's validity. The findings indicate that a toy that lets children create, segment, organize and link oral language through play with a tangible toy in a social setting helps them practice important cognitive skills crucial for later literacy. Preliminary data also suggest that such a toy can help identify children's language learning disabilities and the linguistic strategies used by children of different socio-economic strata. Both TellTale and the composition model on which its design was based suggest several new ways digital media can let children become engaged and skillful authors.

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contents

1	introduction	11
2	scenarios	21
2.1	a single child playing with telltale	21
2.2	two children playing together with telltale	27
3	literacy theory	32
3.1	introduction	32
3.2	literacy as “external meaning-making”	33
3.3	emergent literacy – an introduction	36
3.4	definitions of emergent literacy	37
3.5	emergent literacy and media: oral versus written language	41
3.6	emergent literacy and composition theory	45
3.7	the telltale composition model	50
3.7.1	voice	51
3.7.2	structure	51
3.7.3	reference	52

3.7.4	reflection and revision	52
3.7.5	sharing and discussion	52
3.8	literacy and play	53
3.9	applying the telltale composition model: two approaches	57
3.9.1	the first approach: literacy and socio-economic strata	57
3.9.2	the second approach: literacy and language learning disabilities	61
3.10	conclusion	63
4	related systems	65
4.1	introduction	65
4.2	tape recorders	66
4.3	sony card repeater	68
4.4	concept keyboards	69
4.5	pets	70
4.6	kidpad	71
4.7	graphic story writer	74
4.8	story isis	76
4.9	neurosmith toys	77
4.10	leapfrog toys	78
4.11	sam: the castlemate	79
4.12	triangles	80
4.13	dolltalk	81

4.14	animal blocks	82
4.15	storymat	83
4.16	conclusion	85
5	design	87
5.1	introduction	87
5.2	why design a tangible toy?	88
5.3	early design experiments	93
5.4	telltale version 1.0	94
5.5	telltale version 2.0	97
5.6	telltale version 3.0	102
5.7	conclusion	104
6	evaluation	106
6.1	introduction	106
6.2	the first study: a pilot	109
6.2.1	method	110
6.2.2	features of children's play with telltale	112
6.2.2.1	<i>cohesive language</i>	112
6.2.2.2	<i>telltale structure, story structure</i>	114
6.2.2.3	<i>dialogue construction</i>	116
6.2.2.4	<i>group play</i>	117
6.2.2.5	<i>editing: telltale as a "story processor"</i>	119
6.2.3	summary	120
6.3	the second study: evaluating segmentation	123

6.3.1	method and data analysis	123
6.3.2	quantitative results	126
6.3.3	qualitative results	128
6.3.3.1	<i>composition process</i>	128
6.3.3.2	<i>beginnings and endings</i>	128
6.3.3.3	<i>dialogue construction</i>	129
6.3.4	summary	129
6.4	the third study: evaluating collaborative authorship	131
6.4.1	method and data analysis	131
6.4.2	sample stories	133
6.4.3	quantitative results	135
6.4.4	qualitative results	137
6.4.4.1	<i>incorporations</i>	137
6.4.4.2	<i>“non-narratives”</i>	137
6.4.4.3	<i>turn-taking</i>	137
6.4.5	summary	138
6.5	interviews with teachers	139
6.5.1	current classroom activities	141
6.5.2	proposed classroom uses of telltale	143
6.6	conclusion	146
7	future work	148
7.1	introduction	148
7.2	future evaluations	148
7.3	future designs	150

7.4	future research directions	154
7.5	conclusion	156
8	conclusion	157
	references	160

1: introduction

But it is in the process of composition – in ‘wrestling with words and meaning’ – whether to render subtleties of feeling, to convey precise observation of objects, or to develop a coherent line of reasoning, that one ultimately becomes most fully aware of the power – and limitations – of the written language.
(Wells, 1981)

Old distinctions between learning and play, computers and toys, consuming and producing are changing as both digital media and our relationship with technology evolve. There are now new ways to design toys that can support children’s language development.

But this new opportunity also brings serious challenges. How can technology designers allow children to author – letting them control both the structure and content of language – instead of passively consume stories during traditional play? And how will this new opportunity affect our current design strategies? Will we develop technologies that script and limit children’s language play or will we use digital media to rethink how children become skillful and passionate producers of language?

This thesis investigates a particular aspect of this new opportunity. Specifically, it claims that a tangible, technology-enhanced toy that supports oral language composition can help children acquire certain skills crucial for later written literacy.

To investigate this hypothesis the scope of the claim needs to be constrained and defined along a number of dimensions. First, the claim addresses the possible role of *tangible, technology-enhanced* toys in children's language development. I will therefore argue the relative merits and limitations of interactions that occur away from the desktop and in the child's traditional play environment.

Second, since the claim specifically refers the use of *toys* as tools to support language development, I will argue that play – as compared with instruction by a teacher in a traditional educational setting – is a unique and powerful setting for supporting children's language development.

Third, since the claim places central emphasis on the role of an object as a tool for language learning, the thesis reviews existing systems (hardware, software, technological, non-technological) that claim to support children's language development. This project intentionally departs from the much of the current educational technology designs that emphasize the role of screen-based, graphical user interfaces (GUIs). It instead introduces a new tangible user interface (TUI), called TellTale, designed for children's traditional

language play.

Fourth, the thesis limits the scope of “language development.” In particular, I argue that certain *written* composition skills can be developed by creating and manipulating *oral* language. Implicit in this argument is the claim that the cognitive skills required for composition are independent of the medium in which the language is represented. A detailed review of the relationship between oral language development and written composition skills is presented with respect to the existing “emergent literacy” theory. Indeed, a clear definition of literacy is required before the effect of technology, toys or tangible interfaces on children’s written language development can be properly investigated.

In this thesis, the object is not the argument. Although an artifact – the toy TellTale – is discussed in detail, it is intended to be only a single instantiation of a model that proposes a link between oral language composition and written literacy. This thesis does *not* claim that TellTale is the ideal toy for supporting children’s language development; nor does it claim that the composition model presented here is fully-formed and simply awaiting implementation in toys. A different artifact may do a better job of investigating the developmental phenomenon; a different model of composition may be better suited to the interface. The over-arching goal of this thesis is to provide a new interpretation on an existing theory of literacy to investigate how compatible the features of this composition model are

with the features of a specific tangible interface.

The research and development process was guided by three principles: first, a “feature-based” approach to both the user interface (*i.e.* the toy) design and the theory development; second, a “literature-based” approach that relies heavily on – but, as will be shown, departs slightly from – the existing theory of “emergent literacy” to propose a new oral and written language composition model; third, an “evaluation-based” approach that considers how children use TellTale and how this use can be analyzed within the “emergent literacy” theoretical framework.

The “feature-based” approach argues that there are certain characteristics of children’s oral language that may lead to particular aspects of children’s written literacy development. It further argues that these common features can be supported in a single user interface. This approach allowed the interaction design to be constrained (*i.e.* why certain decisions were made regarding the artifact’s physical design and the environment for which it was intended), the linguistic theory to be developed (*i.e.* how to apply current research on emergent literacy to the interaction design) and the evaluation strategy to be designed (*i.e.* what empirical evidence should be adduced to evaluate the interface’s effect).

The “literature-based” approach relies on the existing theory of emergent literacy. Briefly, this theory states that children do not develop traditional

literacy skills – the ability to understand and produce written language in a conventional and competent, socially-accepted manner – through a sequence of mutually exclusive stages. Instead, “emergent literacy” states that children develop conventional literacy skills along a developmental continuum in which both oral and written language skills are acquired simultaneously through immersion in environments that support social use of a variety of media (Sulzby, 1996; Whitehurst and Lonigan, 1998; Kies *et al.*, 1993; Wolf and Dickinson, 1986; Garton and Pratt, 1986).

Most emergent literacy research investigates the processes by which features of oral language appears in written language use. This thesis combines this same theory with the development of a children’s TUI to investigate how children use features of written language in oral constructions. As such, it propose the TellTale Composition Model that argues how the written composition process can be supported in a purely oral medium. Specifically, this thesis focuses on how children establish narrative cohesion during both individual and collaborative oral story constructions. It investigates how TellTale supports this behaviour and what insight these oral cohesion-building strategies give us into the relationship between children’s oral language use and their development of later written literacy skills.

This approach also helped guide the “evaluation-based” approach. By grounding testing in a theory of “emergent literacy” and a model of composition, protocols were developed that evaluated the role of specific

interface features in relation to the composition process it was designed to support. A broader, secondary goal of this evaluation strategy is to better understand how empirical testing can be designed to be relevant to the design of TUIs, learning interfaces and theories of developmental linguistics.

It's also important to note that this thesis tries to avoid the word "storytelling." The reason for doing so is that this term is often used to describe face-to-face discourse, performances or presentations during which a story is acted out. The term often implies the presence of a co-spatial, co-temporal audience that gives feedback, provides context and defines a general interaction framework. This is rarely the case when composing written text. In this document, terms like "oral authorship," "audio construction" and "story construction" are instead used to emphasize the distinction between performing for an audience and composing an audio "text."

This document is divided into eight chapters. This first chapter describes the structure and the scope of the thesis argument. It states the research's central claim and describes the investigative approach.

The second chapter presents two scenarios that illustrate how TellTale was used. It is important to note that these scenes are not fictional descriptions of how the interface may be used in future sessions; they are aggregates of several actual user studies. They describe how the interface may be used

either alone, in pairs or in small groups. Both scenarios emphasize the authorship model presented in Chapter 3, namely, how children can use TellTale to create oral stories in ways that may be similar to how written text is constructed.

The third chapter describes the rich body of developmental linguistic and psychology literature upon which many of the thesis' claims rest. The review first briefly describes traditional views on literacy and several folk theories of children's language development. It then focuses on the theory of "emergent literacy" with special emphasis on those aspects of children's oral language thought to be related to written literacy development. Since this thesis situates its investigation of children's language within the context of storytelling play, this chapter also describes the narrative and play theory on which TellTale's design and evaluation was based.

Based on the review of literacy, play and narrative research, this chapter concludes with a theory of oral-written composition and a brief description of how this theory might be applied to two domains. The first is how children of different socio-economic strata (SES) develop emergent literacy skills. The second is the relationship between children's language learning disabilities and emergent literacy skills. (An investigation into the first domain – and how the proposed model of composition and TellTale may be relevant – is described in Chapter 6, "Evaluation.")

This third chapter is not intended to be a comprehensive review of all research related to children's literacy. Instead, it is intended to give detailed descriptions of specific theories and studies related to "emergent literacy" and how they relate to the oral-written continuum of language development.

The fourth chapter reviews technological and non-technological systems related to children's development of oral-written language skills through storytelling play. Specifically, the systems are reviewed in relation to how well they address the theory of oral composition described in the third chapter. Special attention is paid to the claims these systems make that are related to the role of tangible technologies as tools for supporting children's language development.

The fifth chapter describes the design process and technology used to create the three iterations of TellTale. Certain TellTale features (*e.g.* a tangible technology, the ability to record audio, a modular interface) are reviewed in relation to the supporting developmental literature. Each of the three TellTale design iterations is then reviewed along with the rationale for each version's design and manufacture.

The sixth chapter describes the evaluation of TellTale. Specifically, it reviews three user studies: the first is a pilot study on children's general play with the toy; the second is a specific investigation of how the interface's modularity is related to children's use of cohesive language; the third is a comparative

evaluation of how children of different socio-economic strata use the interface. The chapter also critiques each of the three studies, pointing out possible flaws in the experimental protocols and discussing how well the operationalizations actually addressed both the interface design and emergent literacy hypotheses. The chapter concludes with a brief review of several structured interviews and design critiques conducted with primary school teachers. The chapter concludes with a summary of all three studies' findings and how they relate to the model of authorship described in Chapter 3 and the design motivations described in Chapter 5.

This discussion leads to the seventh chapter, a review of future work. Based on the user studies and design critiques, several ideas for new designs and evaluations are presented. The chapter concludes with a brief description of how the thesis' claim might be broadened to guide future investigations.

The eighth chapter summarizes the thesis' claim and the evidence presented. With respect to the design and evaluation research, several conclusions are made related to both interface design and developmental theory.

(A minor note: in several parts of this thesis, references are made to Irish children's language development and the Irish Government's English language curriculum. Also, the third user study was conducted at two Dublin schools. The principal reason for this approach was that part of this research

was conducted during a semester spent at Media Lab Europe in Dublin.)

Although the inspiration for TellTale came from current literacy research, it is unrealistic to state that the toy is simply an implementation of a fully formed theoretical model. The model's general framework determined the initial design but, as development progressed and children began to use the toy, both the model and the toy evolved.

This thesis' general approach can be described in the following manner: on the basis of a literature review and early field studies, a set of cognitive and behavioral features were developed to describe an existing developmental phenomenon. These features then guided the design and development of an interaction model and interface prototypes in which user characteristics, environmental properties and theoretical hypotheses were modeled. Next, an evaluation strategy was designed and executed that investigated the thesis' core claim by testing some – but certainly not all – aspects of the hypotheses, the interaction model and the interface.

2: scenarios

The following two scenarios demonstrate how children may use TellTale. While the events and users described in these scenarios are fictional, they are based on actual user tests and observed play patterns.

The right column describes the scenarios, written as third-person narratives. The left column contains meta-comments that highlight various aspects of the scenarios. Meta-comments also make reference to current literacy research and user testing results.

2.1 a single child playing with telltale

TellTale is primarily designed for use in a home by children aged 4-7 years old. It requires no familiarity with computers.

Sheldon is a five-and-a-half-year old boy who's just returned from school. As a surprise, his mother has bought him a new toy called TellTale. The toy looks like a caterpillar and consists of 6 individual pieces (5 body pieces and a single head piece).

TellTale is designed to be used in a physical play environment by children who may have little interest or ability in traditional, classroom-based language tools and activities.

TellTale has no accompanying instructional material and is designed to be used without adult guidance or supervision. Recording begins by opening the body piece and stops by closing the body piece. The audio is then “inside” TellTale. It is played by pressing a button on the outside of the body piece. While the audio is playing, the entire body

His mother hasn’t told him what the toy does but she hopes that it might help him make his own stories. Sheldon often uses action figures to narrate long and complex stories but his kindergarten teacher is concerned about his lack of interest in storytelling and other classroom language activities. Although he is able to print his own name and copy letters from the board, he consistently refuses to write words or short sentences to compose his own stories. Sheldon’s mom has heard him say that he “can’t make up stories.” She is concerned and hopes this new toy may help.

After pulling the toy out of the package, Sheldon begins to experiment. He discovers that each TellTale piece consists of two half-spheres joined together with a hinge. They’re like oyster shells. The top half-sphere is made of translucent plastic and the bottom half-sphere is a bright solid color. Upon opening one of the red body pieces, Sheldon sees a single red LED light up; he giggles slightly and snaps the body piece shut. On the outside of the body piece, Sheldon sees a large green button

piece glows green with a brightness proportional to the audio's amplitude.

This visual cue is intended to help users follow the audio's location as it cascades through TellTale.

During solitary play, children consistently used TellTale body pieces to record different sides of conversations, assuming different voices for the different speakers.

As is explained in Chapter 3, "Literacy Theory", the ability to use language to assume multiple perspectives is considered an early example of "decontextualized language," an indicator of later written literacy skills.

the body piece Sheldon sees a large green button.

He presses it and the body piece immediately lights up bright green. He hears his own giggle and, when the noise stops, the light dims.

Sheldon continues to record funny sounds into the body piece. His final recording is a deep-voiced "Wassup?" He then turns his attention to the yellow body piece. Using it the same way as the red piece, he records a high-pitched "Not much!" He repeatedly plays both the red and yellow body pieces.

He then notices that both the red and yellow body pieces have connectors coming out of their fronts and backs. He connects the body pieces – with the red piece first and the yellow piece second – and presses play on the red piece. As he did earlier, he sees the red piece light up while hearing his low "Wassup?" recording. This time, though, after this recording ends he sees the yellow piece light up and hears his high-pitched "Not much!" recording. Sheldon again laughs and repeatedly presses play on the red body piece to hear the

TellTale lets children control the timing, content and organization of all recorded audio.

During solitary play, children frequently spoke directly to the toy, giving it a name and assuming its first-person identity during storytelling.

TellTale's physical scale and separation from the computer let children incorporate it into their play with traditional toys. (Here, the child's other toys become the audience.)

TellTale lets children edit their audio at any time, as often as they like.

The five TellTale body pieces are four different colors (blue, yellow, purple, red); there are two

cascading audio. He also experiments with the timing of the play-backs, sometimes pressing both body piece's play buttons simultaneously to hear different configurations of his recorded dialogue.

After doing this for several minutes, Sheldon picks up the head piece, looks at it and says "What's your name, Mr. Caterpillar? I know, I'm going to name you and have tell a story to my other friends." Sheldon pulls from his toybox a Pokemon doll, his dad's old Luke Skywalker figurine and his sister's Barbie doll. He throws all three toys into the back of his monster dump-truck and says "okay, you guys listen."

Sheldon then picks up the yellow TellTale body piece and records "Once upon a time there was ... there was ... there was a ... uhhhh ... yah. No wait, let me do that again." Without listening to his recording, Sheldon closes and re-opens the yellow piece, says "there was this evil monster named Spiro" and closes the piece. He presses the play button and listens to his recording. "Yah, that's it," he says and reaches for two red pieces,

purple, red); there are two red pieces. Children often used the body pieces' colors to represent relationships between the audio they contained. (In this case, the child decides that the red pieces are somehow related.)

Although body pieces of the same color may let children make ad-hoc groupings, it may also make distinguishing the content they contain confusing.

But the audio within a given body piece is always associated with that body piece so – regardless of a piece's position within the TellTale macro-structure or visual similarity to another piece – the mapping between body part and audio is always consistent.

During early pilot studies

saying “these go together.” He opens one of the red pieces and says “and they didn’t ... they didn’t know what to do about him.” Into the other red piece he records “the fighter and the wizard were best friends.”

Sheldon then assembles the three pieces he’s recorded thus far but, when he goes to add a red piece to the yellow piece he realizes that he’s forgotten what each red body piece contains. He remembers that they’re related, though, and just puts all three body pieces together. He presses play on yellow piece and starts to listens to his story:

Yellow Body Piece: “There was this evil monster named Spiro.”

Red Body Piece: “The fighter and the wizard were best friends.”

Red Body Piece: “And they didn’t ... they didn’t know what to do about him.”

Happy with his story thus far and forgetting about the assembled audience of toys, Sheldon calls his mother upstairs to his room “Mom, I made something you gotta hear!” Sheldon’s mother arrives and he plays the story for her. She listens

– in which children played alone and parents were nearby – children would often spontaneously bring their parents into the experiment room to listen to their story.

During such impromptu presentations, parents and children were able to discuss and edit the stories. Children were also able to refer physically (by pointing or making reference to a body piece's color) to different parts of their stories. Such reference is usually only possible through interactions with written or pictorial artifacts, not during conventional, conversational oral storytelling.

(As further explained in Chapter 3, "Literacy Theory", the ability to refer to language is indicative of advanced metalinguistic abilities.)

Children are able to construct a TellTale story in any order. (Here, the beginning is added last.)

Practically, though, children tended to record their stories in the same order as the physical arrangement of the body pieces. The important point to note is that, although the final *form* of a TellTale story is linear, the composition *process* is

arrives and he plays the story for her. She listens to the story, following the audio as each body piece lights. Sheldon then jokes "I'd laugh if that part [pointing at the last red body piece] went first." After joking around and trying new configurations of the three body pieces, Sheldon's mom asks Sheldon "why don't you make a beginning?" and "what happens to Spiro?"

She leaves Sheldon alone and he returns to playing.

Looking at the blue piece he gets an idea. Into that piece he records "okay, guys, here's the story.

Once upon a time there was all these guys who lived in a space station." He attaches the head and listens to the new story:

Blue Body Piece: "Okay, guys, here's the story. Once upon a time there was all these guys who lived in a space station."

Yellow Body Piece: "There was this evil monster named Spiro."

Red Body Piece: "The fighter and the wizard were best friends."

Red Body Piece: "And they didn't ... they didn't know what to do about him."

After listening to this story he thinks that the story might sound better if the part about the fighter

determined by the child
and can be non-linear.
(The composition model
on which this interaction
design is based is
described in Chapter 3,
“Literacy Theory.”)

One group of children
used TellTale to plan
their story before
transcribing it.

By transcribing their own
story, children may begin
to consider the
differences between oral
and written language in
ways not usually possible
when an adult transcribes.
Children may discover
how meaning is
represented differently
through the various
features of each medium
(punctuation,
capitalization, prosody,
intonation, etc.).

might sound better if the part about the fighter
and wizard came after the part in which Spiro is
introduced. He switches for order of the yellow
body piece and the first red body piece.

Satisfied with how his story is progressing,
Sheldon reaches for another body piece and
continues recording. After spending about twenty
minutes recording, Sheldon calls his mom back
upstairs to hear the final product. She again listens
to the story and says that his grandfather, who
lives in Canada, would probably love to hear this
story. After agreeing that it would be impractical
to mail TellTale to Canada, Sheldon’s mom
suggests that he write down what he’s recorded so
they can mail it to his grandfather in a letter.
Sheldon is excited to write his first letter and
reaches for a pencil ...

2.2 two children playing together with telltale

TellTale is designed to
support group or paired

Lisa and Anne are seven years old, best friends and

story construction.	avid storytellers. They routinely meet to create elaborate fantasy narratives. They often perform their stories for friends and family and sometimes publish small illustrated booklets. They are best described as “power users,” each owning their own TellTale. Today, they are meeting to make their next play. It’s for a class project and the teacher said they could use the show-and-tell time to present their story.
In addition to being a composition tool, TellTale may also be used to present a completed story.	
All TellTale body pieces are functionally identical, making it possible to combine multiple sets.	They begin by pooling their collective TellTale body pieces (twelve altogether, including two head pieces). Lisa earlier suggested that the story have two main characters and that each TellTale contain each person’s lines. Anne agrees but says that, before recording, they have to “plan what the story is going to be about.” It’s decided that the story will be about two girls who tour the South Pacific on a small boat and all the adventures that happen to them. Lisa and Anne take their six respective TellTale body pieces to opposite sides of the room and begin recording their stories in hushed tones.
Each body piece or group of pieces can represent whatever linguistic unit the child chooses.	
Segmented body pieces (not tethered to each other or a computer) let children play in the same physical space while still maintaining a certain amount of independence and secrecy.	After several minutes they rejoin and play their

During paired user testing, children often realized the extent of their or their partner's assumptions only after explicitly recording story segments.

To resolve these conflicts, children would often divide a story into conceptual pieces (characters, events, descriptions, etc.). This activity seemed to help children make compromises about the story's content and organization.

During joint composition, children seemed to use TellTale body pieces to negotiate two types of turns: intra-story *event turns* and extra-story *discourse turns*. *Event-turns* seemed to help children organize story content while *discourse turns* seemed to help children negotiate their play interactions.

To indicate cohesion between story segments,

stories. Upon hearing each other's recordings, the girls realize that – despite their earlier planning – each has made different assumptions about how the story will be constructed. For instance, they used different names for the main characters; Lisa thought the two girls were on a power boat while Anne's story refers to a sail boat; in Lisa's story, the girls learn to fish from the boat to survive while in Anne's story the main characters become shipwrecked on an island and eat only bananas. After much negotiation, the girls agree on what parts to keep and what parts to use for future stories.

Lisa and Anne start recording the dialogue:

Anne's blue body piece: "This is a story by Anne and Lisa. Once upon a time, there was these two girls ... that were trapped in the ocean!"

Lisa's yellow body piece: "But they had a boat to sail on so things weren't that bad. 'What a beautiful day it is today,' one girl said. But right then, there was a terrible ... a terrible ..." [rising intonation, gestures to Anne to continue]

Anne's yellow body piece: "storm that blew the ship way off course and

children used a number of different strategies: syntax-based connectives (e.g. conjunctive phrases); non-verbal cues (e.g. gestures and eye-gaze); paralinguistic behaviors (e.g. rising prosody). These strategies are further described in Chapter Six, “Evaluation,” and, after preliminary analysis, seem to be correlated with both socio-economic strata and the nature of TellTale’s segmented interface.

Children repeatedly – and unexpectedly – used TellTale to record music and sound effects to accompany their stories. In Chapter Seven, “Future Work,” some concept designs are presented to better

they had to work very hard not to sink. But that night ...”

Lisa’s red body piece: “the storm got so bad they decided to jump off the boat and swim for shore. Even though their mom’s didn’t want them to.” [At this point, Anne says “No, Lisa! The moms weren’t there. There was no one there, remember? Don’t say that.” Anne says “Oh, yah, I forgot” and re-records the story piece.] “the storm was the worst in fifty years so they jumped into the water and swam for land.”

Anne’s purple body piece: “and ...” [with rising intonation, looking directly at Lisa]

The girls continue recording story turns and, after numerous re-recordings and several body-piece rearrangements, they decide that the story is complete.

They attach all the body pieces together and play the story through several times. Lisa notices that there are three body pieces left over and suggests that they make a sound-track for their story. Anne records loud thunder and lightening sounds into one body piece while Lisa makes jungle animal sounds into another piece. Anne decides, though, that they should have both of these sounds in one

support this behavior.

Another unanticipated use was children's habit of "re-chunking" audio by "copying and pasting" sounds from one or more body pieces into another.

During paired user testing, the two children would sometimes construct two separate and shorter stories instead of one long narrative.

These stories were sometimes meant to be played simultaneously (requiring careful timing) but were often designed to be two stand-alone stories. One pair of children used TellTale to record rap music, experimenting extensively with different timings by playing consecutive body pieces in different orders.

(Note that each time a chain of connected body pieces is played, a cascading audio "track" begins. Thus, playing a single chain multiple times causes multiple tracks to be played and, depending on the timing of play commands, overlapping sounds can result.)

body piece. While opening up the third piece to record, she plays the other two, "copying" both storm and jungle sounds into a single body piece.

"There, " Anne says, "now we've got two more pieces." Lisa then records splashing sounds into the first body piece and wind-blowing sounds into the second body piece.

The girls attach all three pieces together and lay this shorter body-piece chain next to the longer chain that contains the story. Lisa presses play on the longer, story-containing chain while Anne waits until the right moment to start the shorter sound-effects chain. The girls experiment with the timing of the story and sound-effects chaining and finally settle on a performance they're happy with.

Anne loads the story chain into her back-pack while Lisa puts the sound-effects chain into her bag. They are ready for tomorrow's presentation.

3: literacy theory

3.1 introduction

This research is guided by three principles. The first is that feature-based user interface development can guide toy design in a way that is sensitive to children's actual play patterns. It can help frame hypotheses about how and why children are using certain characteristics of an interface. The fifth chapter, "Design," discusses this point further.

The second principle is that empirical evaluation of children using toys can help adduce evidence for hypotheses about literacy acquisition. The sixth chapter, "Evaluation," further discusses this point.

The third principle is that both theoretical models and interface designs should rely on what we already know about how children learn language. This chapter reviews current research on children's literacy acquisition and explains how this literature lead to the development of TellTale and the TellTale Composition Model. Specifically, this chapter reviews how TellTale

was designed and evaluated by combining the existing theory of “emergent literacy” with a new model of composition that spans both oral and written media.

This chapter also outlines two potential applications of this approach: how children’s language composition skills may be related to their socio-economic strata; and how media-independent composition may help children with language learning disabilities.

3.2 literacy as “external meaning-making”

The entire approach described within this thesis rests on a specific and practical definition of literacy. To frame this definition, it is helpful to review briefly some traditional and philosophical views of what literacy is and how children acquire literacy skills.

Wells (1981) argues that there are 3 major phases of language development. The first involves discovering that language is a pattern of sounds that have meaning and purpose. Children in this stage learn that language is a way to regulate activity and that language can represent things in the world without actually *being* the things in the world.

The second phase involves discovering the cultural aspects of language. Namely, that assumptions and values are encoded in particular linguistic representations and that these values are specific to particular

communities. Examples include learning linguistic registers (*e.g.* the style of language used on the playground is different from the style of language used at church), social requirements (*e.g.* speaking to someone in a position of authority requires different language than speaking to a peer) and speech acts or performatives (*e.g.* certain utterances made in certain contexts – like apologies or requests – can have pragmatic consequences).

In essence, Wells argues that after children learn that language enables representation (the first stage), they learn that language has social and pragmatic consequences. These first two phases involve a close link among language, action, context and culture. Wells states that there is a third stage of development that involves the creation and manipulation of language designed for an audience that is spatially or temporally separated from the author. Wells thus defines “literacy” as the ability to communicate with an audience that is in a different space and a different time

His fundamental assertion is that literacy is the ability to create external communication – or “make meaning” – across space and time.

In this third phase, language begins to have permanence. It can be used for reflection, memory and sharing meaning with others currently not present. Children’s use of literate language occurs, in a sense, the first time *meaning* is separated from *context*. In this way, language becomes “decontextualized.” When writers “decontextualize” their language they are, in a sense, designing

communication for a displaced audience. They are anticipating assumptions and, as far as is possible, are trying to create language that will be interpreted in the manner they intended. Considering literacy as the creation of “decontextualized” language is a central aspect of this research.

For children to achieve this third level of language, they must be able to create, manipulate, organize, share, edit and comprehend decontextualized language. One method for becoming familiar with decontextualized language is through the creation of written artifacts that serve as a basis for interpretation, argumentation and perspective-taking.

Indeed, most traditional definitions of literacy only consider how children learn to create and understand text. These definitions assume that literacy primarily involves reading and writing and that children need to receive active instruction on how to interact with text. For example, Olson (1977) claims that literacy is closely coupled with text arguing strongly that “the ability to decontextualize language results from the manipulation of written media.” Hicks (1990) states that conservative definitions of literacy label someone literate if he or she can “comprehend and produce written media.” Pontecorvo and Orsolini (1996) argue that “traditionally, written language has been assumed to be a process that is learned through instruction, that written language instruction lets children transfer linguistic knowledge to a visual rather than auditory modality.”

But what about children who cannot yet write? Are they also capable of creating and organizing decontextualized language?

This thesis claims that children who are not yet capable of reading or writing can independently produce linguistic artifacts – in the case of TellTale, “audio texts” – that let them create and manipulate decontextualized language. In essence, I argue that the process of creating decontextualized language is independent from the medium in which meaning is encoded. A core assumption of this argument is that Wells’s “external meaning-making” process is a fundamental cognitive process and is not tied to the specific properties of any medium. Children do not magically acquire the ability to compose language at the same time that traditional literacy instruction begins.

To investigate this issue, a model of literacy is required on which this medium-independent, child-created view of decontextualized language can rest. Reviewing the theory of “emergent literacy” is a useful way to begin building this model.

3.3 emergent literacy – an introduction

As a preamble to the discussion of “emergent literacy” it is worth briefly revisiting Wells’ theory of language development for one specific reason. Although his three-stage model of language acquisition seems to support a text-specific model of literacy, his description of the written composition

process actually involves no specific mention of text.

Wells (1981) states that: “writing involves: a) assembling the relevant meanings and organizing them in a structure appropriate to the particular narrative, argument, description, etc.; b) shaping the material so that it is oriented to the expectations and information which it can be assumed the intended reader will bring to the text; c) encoding it in words and syntactic structures which coherently, explicitly and elegantly express the intended message.”

In constructing his generalized model of language development, Wells in fact departs from the traditional definition of literacy acquisition and – without using the exact term – supports a medium-independent theory of “emergent literacy.”

3.4 definitions of emergent literacy

There is general agreement among researchers that children know much about reading and writing long before they become conventional readers and writers. Sulzby (1996) argues that children acquire the ability to read and write through immersion in environments in which both oral and written language are being acquired simultaneously. However, there is little agreement on exactly how the features of oral and written emergent literacy skills overlap and how they are related to later conventional literacy skills.

Whitehurst and Lonigan (1998) offer perhaps the most inclusive definition of emergent literacy: “it is the skills, knowledge and attitudes that are presumed to be developmental precursors to reading and writing and the environments that support those developments.” They go on to state that emergent literacy is “a developmental continuum, with its origins early in the life of a child, rather than an all-or-none phenomenon that begins when children start school.” They also argue that the emergent literacy model supports “social interactions” among pre-readers and pre-writers in “literacy-rich environments.” Another distinction Whitehurst and Lonigan draw is between “emergent literacy” and “conventional literacy.” They state that “emergent literacy” assumes that “reading, writing and oral language develop concurrently and interdependently from an early age from children’s exposure to interactions in the social contexts in which literacy is a component and in the absence of formal instruction.”

Kies *et al.* (1993) provide a slightly different definition of “emergent literacy” (they actually use the term “beginning literacy”): “the skills most children have developed prior to entering school but to not include how to read or write independently.” This definition is somewhat ambiguous but the “skills” they refer to are likely related to language. It is also unclear exactly what it is meant by “read or write.” Does reading involve simply the oral expression of graphemes or does it require a certain level of comprehension? And what exactly qualifies as “independent” behavior?

Garton and Pratt (1989) use a Piagetian-like stage model to describe emergent literacy development. They identified a “pre-literacy stage” as the “earliest phase of development of reading and writing.” Again, it is unclear exactly how early this phase begins or what aspects of reading and writing the child must perform to be considered in this stage. Wolf and Dickinson (1986) use a similar definition but, to avoid an explicit stage model, simply use the term “pre-literacy.”

There seems to be much confusion surrounding exactly what “emergent literacy” is. Generally, though, the term describes a marked shift from earlier, more conservative views of literacy acquisition as simply learning to read and write. Despite differences in terminology and application, current literacy theorists seem to agree that children acquire conventional literacy skills along a developmental continuum in which both oral and written language skills are acquired simultaneously through immersion in environments that support the social use of a variety of media.

To address the confusion associated with competing terms and differing theories, Whitehurst and Lonigan proposed that emergent literacy actually consists of at least two distinct types of abilities: *inside-out skills* and *outside-in skills*.

Inside-out skills are abilities associated with what might be called “low-level” aspects of language including: knowledge of graphemes, phonological

awareness, syntactic awareness and phoneme-grapheme correspondence. *Outside-in skills* are abilities associated with what might be called “high-level” aspects of language including: semantic, syntactic and conceptual knowledge; understanding and producing narrative; understanding and demonstrating conventions of print; emergent reading and retelling. Such distinctions help further differentiate between emergent and conventional literacy skills and can begin to suggest ways in which children’s emergent literacy skills can be supported through different tools and activities.

Another aspect of language development usually associated with emergent literacy is “metalinguistic awareness.” For the purposes of this thesis, metalinguistic awareness is defined as “knowledge about language – for instance, an understanding of what a word [or story segment or discourse turn] is and a consciousness of the sounds of language.” (Berko-Gleason, 1997). (For an extensive review of children’s metalinguistic development, see Gombert (1992).)

Garton and Pratt (1989), Gombert (1992) and Nippolo (1988) all agree that metalinguistic awareness is one of the critical aspects of early literacy development. Whitehurst and Lonigan (1998) also address metalinguistic awareness in their model of “emergent literacy” stating that a child’s ability to recognize and sequence segments of language is critical. Garton and Pratt (1989) state, however, that the exact type of metalinguistic awareness related to later literacy development is not yet known. Bryant and Bradley (1985)

suggest that it, in very young children, it may be linked to children's ability to produce rhyming language.

In summary, the general theory of emergent literacy states that children acquire reading, writing and oral language skills from an early age concurrently and interdependently through social and metalinguistic interactions with a variety of media and in the absence of formal instruction.

3.5 emergent literacy and media: oral versus written language

All the various theories of emergent literacy state that children acquire literacy skills along an oral-written continuum. Indeed, children do not read and write spontaneously, but are instead gradually able to create and comprehend written language while they are still deeply immersed in oral language.

As this thesis specifically focuses on supporting children's ability to create "audio texts," it is helpful to review existing literature on the relationship between children's oral and written language development.

Sulzby (1996) argues that young children often "speak written language" and "write oral language". She claims that children use characteristics of conversational language and oral monologues when they attempt to read

story books. Sulzby also observed that, when talking in formal monologues, some children engaged in “book-talking.” She argues that this formalized form of speech has characteristics of written language: it contains few disfluencies, adopts a neutral tone and has a formal structure that resembles organized text. She cites “book-talking” as evidence that children acquire emergent literacy skills through the combined influence of oral and written media and genres. While Sulzby only examined such behavior in relation to story *comprehension*, one of the principal assumptions of this thesis’ claim is that children may also use certain aspects of written language during oral story *composition*.

Pontecorvo & Orsolini (1996) also state that “written language is not limited to the written medium and that text-like language can be found in oral language.” They found that children use common strategies to produce written and oral language but, like Sulzby, they only consider children’s oral expression of existing written language and not children’s creation of original oral language.

Hidi and Klaiman (1984) argue that the ability to construct a two-sided dialogue is a precursor to written text construction. They found that children who transcribed their own dialogues on expository topics produced texts that were longer and more complex, perhaps using features of oral language to facilitate text authorship. They argue that dialogue construction is a form of “self-cueing” and that it requires the ability to decontextualize language by

simultaneously assuming two different perspectives for an audience that is not present.

Bereiter & Scardamalia (1982) also argue that written composition fundamentally involves adapting oral language. In more formal terms, they state that a writer who creates written text based on oral language uses “self-cueing in order to generate extended discourse within a schema that is still structured to depend on conversational inputs.”

Michaels and Collins (1984) analyzed spoken narratives produced by children familiar with a literate style and children more likely to use oral-based strategies. The significant differences were in how children introduced characters. The group with a literate style used indefinite nouns with relative clauses to describe the action in which the character was involved (e.g. “There was a man who was picking some pears”). Those children who used oral-based strategies used definite noun phrases with deictic expressions (e.g. “It was about this man”). Thus, familiarity with written style seems to greatly affect children’s use of specific syntactic devices, even when narratives are spoken rather than written.

Zuccheromaglio & Scheuer (1996) were also interested in “a way to study children’s capacity to use a written form of discourse when they do not yet write autonomously.” They classified the properties of 5-year old peers’ verbal interactions for features that may be indicative of composition-like

behaviors. They identified 4 categories of discourse related to the act of composing a written story with a peer: story structure; story planning; decontextualization; composition process.

Torrance & Olson (1984) were also trying to determine which aspects of oral conversation are relevant to the acquisition of reading and writing skills. The discourse features they analyzed were those that contributed to the building and maintenance of conversational topics and children's use of turn-taking skills. They had children complete a number of language games and tasks and then analyzed their speech for pronominalizations, propositions and various other discourse features. The structural analyses suggested that psychological verbs or "verbs of feeling" (*e.g.* think, know, mean, decide, love, hate, care, *etc.*) were correlated with reading ability. They found that use of coordinate conjunctions within turns is also related to the range of psychological verbs used. Those identified as poor readers also tended to use more modifiers and qualifiers in their speech. It is important to note that the data was not gathered while children were engaged in a story-construction task and that the study was principally concerned with correlating features of oral conversation with reading – and not composing – abilities.

In summary, there is a great deal of literature suggesting that children seem to be using a common set of cognitive strategies during oral and written language use. This supports the particular aspect of the emergent literacy theory that states that children develop conventional literacy skills through

interaction with a variety of media.

It is important to note here that this thesis is not arguing that oral and written language are the same, nor is it arguing that written language is simply a transcript of oral language. It merely states that there are aspects of oral language expression that are related to how written text is produced and that we may be able to support young children's emergent literacy development by letting them to author oral language in a way that is similar to how they may later create written text.

3.6 emergent literacy and composition theory

If children seem to be using a common set of strategies when using oral and written language, then these features should also be accounted for in the model of composition that guides the design and evaluation of any artifact intended to support children's authorship. Furthermore, this model should allow for social construction of language through interactions with a variety of media.

The first aspect of the model advocates letting children create their own language instead of relying on prescribed content. Walkerdine & Sinha (1981) argue that it is good for children to compose their own language because it is in composing that they "make and fix mistakes." Pontecorvo & Orsolini (1996) also state that composing and authoring one's own content

has benefits: “writing can greatly facilitate coordination among cognitive activities: it allows what was produced previously to be modified several times. This kind of coordination seems to be much more difficult with oral discourse.”

When children create their own language, and have control over both its content and its organization, they can begin to experiment with how words fit together, what constitutes a story, how others perceive language, *etc.*. Instead of merely consuming or rearranging pre-produced content they create their own language artifacts. Indeed, the most beneficial learning may happen when learners have control over both the structure and content of their materials and are able to critique their thoughts and experiences through social interactions (Papert, 1980).

Pontecorvo and Orsolini (1996) argue that the ability to *structure* language is crucial to children’s writing development: “when elementary children are not taught to plan large chunks of semantic content by writing down ideas and are not trained to revise what they have been writing, texts are produced using strategies resembling those that underlie conversation.” This is not to argue that conversational language is in any way inferior to written language but instead to state that oral and written language use different mechanisms to convey meaning. Pontecorvo and Orsolini’s findings suggest that failing to organize semantic content using written text can lead to later language problems. What is required, perhaps, is a hybrid approach that lets children

plan chunks of semantic content (represented in oral language) in ways that are like how they will later create and revise written text.

It is also important to note that simply being able to form and organize graphemes is not indicative of composition abilities. In her study of classroom literacy instruction, Formisano (1996) found that autonomous composition was only possible at home because, at school, the utterances were usually suggested or dictated. It was the children's job to copy the words or phrases and not engage in composition. She argues that composition is not possible in a written context until the alphabetic code is learned but that reproducing the alphabetic code is often mistaken for original composition. After prolonged observations in the classroom, Formisano stated that "these children could not write, even after they had learned the alphabet because they were not taught to write in the sense of composing real texts with different aims and different audiences in mind." To counteract this, Formisano identified 5 areas that should be further investigated with respect to written composition: 1) symbolization of language; 2) representation of spoken language; 3) spontaneous construction of written language; 4) representation of written language; and 5) reflection on written language.

The Irish Government's English Language Curriculum (Government of Ireland, 1999) also presents a composition model, this one based on children's classroom activities. It states that "drafting, editing and redrafting

is at the heart of the writing process” and that children’s feeling of ownership over their writing can give them greater control over their own language. With specific respect to the editing process, the curriculum states that children should edit a first drafts by “adding to it, deleting from it, reordering it, rewording parts of it” and that, only after extensive collaborative reviews should children proceed to the “publishing phase.”

Several more theoretical models of composition are reviewed here to explain the motivation for TellTale’s authorship method. Bizzell (1986) says that “composing usually refers to all the processes out of which a piece of written work emerges.” While this is a good general guide for the TellTale Composition Model, the emerging “work” that children create is an “oral text.”

When considering how language is composed, it is helpful to separate a work’s final form from the process by which it was created. Specifically, if the final form of a narrative is linear does that mean the story-construction process was also linear? When considering the research upon which TellTale’s composition processes was based, it is important to note that one research goal is to support the creation of a linear form through a non-linear composition process.

The Roman-Wlecke model (as described in Bizzell, 1986) states that successful writing involves 3 stages: pre-writing, writing and editing where

“pre-writing” involves idea generation. This model suggests that composition is a strictly stage-based process in which levels can only be reached after successful completion of previous stages. This model precludes revision of content or organization outside the current stage. For example, it assumes that any insights gained during editing cannot affect idea generation. This process has been criticized for its strictly sequential approach and is an example of a composition model in which the composition process and the final form are both linear.

Nancy Sommers (1980) argues that the composition process is actually the process of revision where “revision” means “rereading, evaluating and making small-scale and large-scale changes to a text as one produces it.” Such a model implies a more chaotic process in which both form and content are under constant revision.

Both Britton *et al.* (1975) and Emig (1971) state that composition is at least partially a product of the context within which the authorship happens. They argue the type of writing the student engages in is impacted by all of the following features: the intended audience, whether reflection and revision is supported and encouraged and whether there is collaboration involved during writing. This model of composition tries to account for the environmental and contextual factors that influence how and what an author chooses to create.

The Flowers-Hayes model (Flower and Hayes, 1981) also takes a broad approach to the composition process. This model divides composing into 3 main parts: 1) the task environment; 2) the writing process; and 3) the writer's long-term memory. The model basically states that the process is not strictly linear and stage-based but is instead the result of many interrelated and contextually-determined factors.

All of the composition models reviewed here support this thesis' argument that any design intended to support children's authorship should support the composition *elements* but not necessarily guide children into a specific composition *process*.

3.7 the telltale composition model

The great amount of uncertainty and confusion surrounding a generalized composition model suggests that there is considerable variety in our current understanding of how people compose texts (oral or written).

TellTale's authorship model is therefore based on the idea of open-ended composition in which the author has complete control over both the content and organization of material at all times. While the product and configuration is always linear (containing a literal beginning, middle and end), the composition process is entirely defined by the user and can involve as many revisions (both large- and small-scale) as needed. Furthermore, these

revisions can be accomplished through collaborative and social reference to and review of the entire story or a small story segment.

This thesis focuses on supporting children's *outside-in* emergent literacy skills, their metalinguistic abilities, and their ability to independently create structure, revise and reflect upon oral language created in their own voice and sequence. The overall goal is to support all these language behaviors in a natural social setting and in a way that is similar to how they will eventually create written text. This approach to story-construction play – upon which the TellTale interface design is based – is defined in the TellTale Composition Model. Each feature of this model is discussed below.

3.7.1 voice

In this model, children create language using their own words and with their own “voice.” When children use TellTale, “voice” means recording their own audio. But more generally, this feature of the model states that children generate their own content. They should not compose by assembling prescribed content or sets of primitives. They should have complete control over what language they choose to create and all aspects of this process should be entirely possible without the help of an adult.

3.7.2 structure

In this model, children organize language themselves, controlling both its

local and global structure. For example, TellTale body pieces are open-ended means of representing any piece of linguistic content (*e.g.* morphemes, words, sentences, paragraphs, events, *etc.*) and children can use whatever strategies they wish to establish narrative coherence.

3.7.3 reference

In this model, children make reference to language segments in whatever manner they choose. For example, using TellTale children can refer to story content by summarizing a body piece's contents ("the part with the beginning"), by pointing to a body piece ("that one [pointing to red piece]"), by making reference to a body piece's linear position ("the second part"), by making reference to a body piece's physical appearance ("the blue one"), *etc.*

3.7.4 reflection and revision

In this model, children reflect upon and edit the exact form of all utterances they create. For example, children using TellTale can review the content contained in that body piece and its relationship to other body pieces. Children can revise and edit a body piece's content at any time during play.

3.7.5 sharing and discussion

In this model, children can share and discuss the language they have constructed. For example, using TellTale, children can collaboratively create

body piece recordings with the help of co-present peers or adults. They can incorporate feedback on the story's content or structure immediately. By creating language for and with others, children may begin to realize how assumptions are made and language is interpreted.

It is important to note that, although this composition model is presented in the context of TellTale's development, it is intended to be broadly applicable. The model describes a set of general principles to guide the design and evaluation of language tools designed to support children's composition. Different toys may emphasize different aspects of the model – for example, TellTale emphasizes structuring language in a linear form – but the guidelines are intended to be general enough to support a variety of different designs.

The next consideration is how and why to support this composition process. There are several tools and activities for encouraging this type of composition but, in this research, a toy was chosen as the tool and storytelling play was chosen as the activity.

3.8 literacy and play

It is reasonable to wonder why, exactly, part of this thesis' claim advocates the use of play as a means for literacy learning. Primarily, it is because it is during play that children first start to creatively influence their environment. In a sense, play is one of the first opportunities children have to – to use

Wells' (1981) notion – “make external meaning.” They begin to experiment with relationships between their real, physical world and their constructed, fantasy world (Bruner, 1986). And, using language, children learn to negotiate and define this relationship (Vygotsky, 1962; Sutton-Smith, 1997; Goldstein, 1994). Play is the one time when children are not just allowed to take “creative risks” – good play *requires* it.

Play is also the time during which much fantasy and collaborative storytelling spontaneously occurs. By using language to describe other worlds, events and characters, children begin to experiment with what successful “decontextualized” language is, how to assume multiple perspectives and how to resolve cognitive conflict between what was meant and what was understood.

Narrative play is also one environment in which children with different linguistic abilities can come together to use and create language. And, with specific respect to the relationship between oral and written literacy, narrative play is an excellent opportunity to support the oral-written continuum described by the theory of “emergent literacy.” Collins (1999) states that “no research literature exists to prove this yet, but I suspect that storytelling is the most appropriate vehicle for bridging the distance between speech and writing in the education of primary age children.”

But some theorists separate play from literacy. Bergen and Mauer (2000)

draw a distinction between “pretend play” and “literacy-related play” where “pretend play” is the imaginary uses of roles, actions and objects and “literacy-related play” is play with the actual materials of literacy such as books and writing implements. Roskos (2000) argues that, indeed, literacy materials should be available in the play area but defines these literacy tools traditionally as pens, pencils, crayons, construction paper, *etc.*.

Others argue for a more integrated approach. Vukelich (1990) suggests that teachers should include literacy materials in classroom drama activities so that children can start to incorporate literacy roles and activities into their dramatic play behaviour. Walker (1999) and Stone & Christie (1996) argue that children’s engagement in literacy activities during dramatic play can provide them with contexts and opportunities for literacy learning.

Play is also one of the contexts of oral language use identified in the Irish Government’s English Language curriculum (Government of Ireland, 1999). It states that “children use play as a way to practise feelings, reactions within situations by creating fantasy worlds which they use to model aspects of the real world they feel are salient. And children use language to help them model and describe this fantasy world.”

One of the goals of this research is to blur the distinction between literacy and play activities. TellTale is designed to be a pretend play toy *and* a literacy play tool. If a toy can support language development in familiar play

environments, perhaps some children will be less inhibited by the formal instruction they will eventually receive in school.

Since children play before (and after) they start attending school, it is the perfect pre-school environment for exposing children to specific literacy skills. If the play environment supports writing-like composition of the kind described in the previous section, children may be more comfortable with classroom text activities when they encounter them. Wells (1981) states that “progress [with written text] is much more rapid if children already have some familiarity with the purposes and conventions of written language when they come to school”

Play is also often a time when children interact with someone of their own or a similar age. Walker (1999) specifically cites the importance of providing “collaborative literacy tools” in the play environment to encourage children to coordinate language activities during play. Vygotsky (1962) proposed that peer interaction provides a “Zone of Proximal Development” within which a range of behaviors exhibited by an older peer or adult can be beneficial to a younger peer. Pontecorvo & Zuccheromaglio (1990) observed this kind of collaborative language play in a classroom setting, arguing that peer interaction provides the opportunity for sociocognitive conflict and – through conflict resolution – language construction. Indeed, collaborative play is quite common and naturally occurring. Garvey (1990) found that children engaged in focused interaction or mutual engagement during play an

average of 66% of the session and Preece (1992) found that children's spontaneous stories involved collaborative telling approximately 70% of the time.

In summary, it is during play that children engage in the social, story-construction language behaviors that seem to facilitate literacy development.

3.9 applying the telltale composition model: two approaches

To evaluate the effectiveness of the toy and the composition model on which its design was based, there needed to be several domains in which the entire approach could be tested. Two such applications are described here: how TellTale may support and further explain the language development of children from different socio-economic strata; and how TellTale may help children with specific language learning disabilities.

3.9.1 the first approach: literacy and socio-economic strata

Children from different socio-economic strata (SES) have different language development experiences. Adams (1990) estimates that the typical American middle-class child enters first grade with 1000-1700 hours of one-on-one picture book reading whereas a child from a low-income family averages just 25 hours. Smith and Dixon (1995) found that even as early as 48 months of age, many low-SES students are at a distinct disadvantage when compared

with middle-SES students in understanding written language. And Dickinson and Snow (1987) showed that children who encounter difficulty with early pre-reading exercises also have difficulty with simple oral language exercises.

While an exhaustive review of the literature regarding language development and SES is beyond the scope of this thesis, there is an apparent trend in the research that is relevant to the design and evaluation of TellTale. Children of low-SES seem to be more at risk for delayed language development and that this delay is often first noticed in children's performance on emergent literacy tasks.

There are several possible reasons for this relationship. One explanation is that – as Adams (1990) argues – children of low SES are not receiving adequate support at home such that by the time they enter school they are already behind their high-SES peers. Another explanation – one suggested by Stewart (1995) – is that low-SES homes are actually conducive to literacy development and school success but that current literacy measurements are not sensitive enough to account for SES differences. Perhaps low- and high-SES children are simply using different strategies during language-based activities but our assessment techniques are biased towards children of high-SES.

Indeed, both Hicks (1990) and Heath (1983) argue that the reason low-SES

children have difficulty with current literacy tests is that current language evaluations are often based on assumptions about narrative that are derived from traditionally white, upper-class notions of what a “good” story is. She argues that children from different socio-cultural communities bring different ways of organizing their knowledge through narrative and that current story-based assessment tools are simply not sensitive enough to these sometimes subtle social differences.

In Hicks’ study, she examined the narrative productions of 70 children (58 from high-SES and 12 from low-SES). She then chose 4 children (2 each from high- and low-SES) whose stories she investigated in depth. (An important methodological caveat is that Hicks offers no rationale for how she chose these 4 children, just that they were a “representative sample.”)

Both groups of children, Hicks reported, produce narratives which were topic-centered, logically organized and engaging. However, she found that high-SES children’s narratives tend to be factual in nature, involving lists or “blow-by-blow descriptions” of events and are told from the perspective of a detached narrator. Low-SES children’s stories tended to contain more descriptions of characters’ internal emotional states and a higher frequency of “psychological verbs”, also called “verbs of feeling.” (Recall that Torrance and Olson (1984) actually saw a positive correlation between children’s use of psychological verbs and their reading abilities.) Hicks’ conclusion was that a detailed analysis of narratives calls into question the idea that either group

is intrinsically more oral or more literate in its style of narration.

Hicks also argues that classroom literacy is usually defined as the ability to assume the “reporter” stance which, she says, seems to be most characteristic of white middle-income children. She suggests that “if educators are to meet the needs of children from a variety of social communities then it may be necessary to make alterations in our current means of literacy instruction.” Michaels (1981) and Michaels & Collins (1984) also suggest that differences in styles of narration can be an obstacle to African-American children’s full participation in classroom literacy events.

The purpose of reviewing such studies in this thesis is to show that there is no clear model of children’s language development that is both sensitive to SES differences and indicative of performance on later literacy tests. Whitehurst and Lonigan (1998) agree that there is little research on the relationship between SES and the *outside-in skills* of the kind TellTale is designed to support. Since children’s oral language abilities are considered to be somehow related to later literacy skills, one goal of this thesis is to use TellTale (and the model of authorship on which its design was based) to investigate this relationship further. As is discussed in Chapter 6, “Evaluation,” children of high- and low-SES may indeed be using different strategies to create coherence during oral story-construction. These strategies are not accounted for in current language assessments and may be

related to the development of later literacy skills.

3.9.2 the second approach: literacy and language learning disabilities

Another application of TellTale and the TellTale Composition Model is to the language development of children with language learning disabilities.

Johnson (1993) states that clinical assessors have historically investigated the relationship between children's oral and written discourse with the hope of discovering how children's early oral language use may be related to difficulties with later written literacy skills. An assessment tool that lets children engage in oral language construction in a way that is similar to how written language is created may help define this relationship between oral and written language disabilities.

Specifically, clinical researchers are interested in how children's creation of "decontextualized" oral language is related to how they will eventually create "decontextualized" written language. (Note that they draw a distinction between the two media – something this thesis explicitly argues against.) Cohen (1983) found "a poor sense of audience in the essays, stories and letters written by students with learning disabilities. Many have difficulty taking the perspective of the reader and therefore omit relevant information. They make assumptions about what the reader knows."

Clinicians and speech-language pathologists have also traditionally used

storytelling as a way to assess language abilities. Silliman (1989) used narrative as a means of identifying “oral substrates of written language disabilities.” She suggests that there are features of children’s oral language impairments that may be related to children’s written language difficulties. She further suggests that the ability to diagnose these features may be useful in treating the language disability as well as better understanding how oral and written language is created.

There are also specific features of children’s oral language learning disabilities (LLD) that are especially relevant to TellTale’s design and model of authorship. In relation to how children edit language, Liles and Purcell (1987) found that non-LLD children tend to repair inaccurate statements more frequently when they occurred and suggest that children with LLD are less able to recognize and fix oral language errors. In another study, MacLachlin and Chapman (1988) found that the narrative retellings of LLD children contained significantly higher rates of communicative breakdowns (including disfluencies) and that the episodes produced were less complete. They also found that LLD children consistently used causal connectives less often to link content across story episode boundaries. Silliman (1989) states that children with LLDs consistently fail to plan and integrate narrative elements, resulting in less coherent stories. Liles (1987) agrees and says that LLD children may offer an opportunity to study what she considers two separate levels of language processing: the use of causal connectives to link

meaning relations and how episodes themselves are constructed.

The reason for reviewing this literature on children's LLDs is that there are features of TellTale's interface and authorship model that may be relevant to the diagnosis and treatment of children's language disabilities. As is discussed in Chapter 6, "Evaluation," a study that specifically manipulated one feature of the TellTale interface design – the segmentation of audio across body pieces – has specific relevance to the LLD literature. Children who used a non-segmented version of TellTale tended to construct stories that appeared to be similar to the stories constructed by children with LLD. Children who used a segmented version of TellTale did not construct such stories.

Although it is too early to make any conclusions about the relationship between the TellTale interface and language disabilities, it would be interesting to investigate further whether TellTale has any diagnostic or therapeutic uses.

3.10 conclusion

This chapter has reviewed existing literature on "emergent literacy" skills and presented the TellTale Model of Composition. The goal of this review was not to create a new definition of "emergent literacy" – there are enough of these already – but instead to use an aggregate of existing models upon which to base a media-independent model of composition. In turn, it

is this authorship model that is the basis for the design and evaluation of TellTale, a toy intended to let children create oral stories in ways that may be similar to how they will eventually produce written narratives.

In the next section, related systems and strategies are reviewed in relation to TellTale and the TellTale Composition Model.

4: related systems

4.1 introduction

To help frame TellTale’s comparison to other systems, it is worth briefly reviewing the thesis’ central claim and summarizing the arguments made thus far.

The first chapter explicitly stated that a tangible, technology-enhanced toy that supports oral language composition can help children acquire certain skills crucial for later written literacy. The second chapter presented two scenarios to demonstrate how TellTale may be used by children to independently and collaboratively create oral stories. The third chapter described related research on “emergent literacy” and, within this theoretical framework, detailed the TellTale Composition Model that guided the design and evaluation of the TellTale user interface.

This model of authorship (that claims to support voice, structure, reference, reflection and revision, and sharing and discussion) is used to organize and motivate the evaluation of the related systems described in this chapter.

This review considers both academic-based research systems as well as commercially available products. However, certainly not all research systems and not all children's toys are analyzed. Special attention is given to children's systems that claim to support the following functions: story-construction; language learning through play; collaborative authorship; and creation of original content as opposed to interaction with pre-scripted language. Since this thesis also argues the merits of tangible, play-centered toys, the review pays special attention to those systems that claim to support natural, physical interactions.

4.2 tape recorders

For many years, children have used a well-established technology – the tape recorder – to record stories and experiment with audio. The success of tape recorders designed for children shows that a relatively simple technology can support elaborate creation and sharing of language (*e.g.* Fischer Price, 2001).

Although a tape recorder lets children author content in their own voice, the interface does not explicitly encourage them to experiment with the structure or organization of language. When using a tape recorder, a child's story is

one continuous piece of audio and the story's physical representation has no relation to the narrative's structure.

figure 4-1:
fisher-price
"tuff-stuff"
tape recorder



Tape recorders are also sometimes used to introduce children to written text by having a parent or teacher transcribe a child's audio story. Wells (1981) suggests that children should "'write aloud' their stories, notice observations and so on, which the teacher can either take down on the spot or recover from a recorded tape later in the day." This process assumes that teachers have the time and attention required to transcribe long segments of audio. It is also questionable whether having an adult transcribe audio encourages children to consider how linguistic meaning is differentially represented in oral versus text media. For example, an adult may interpret a child's meaning, repair pauses and disfluencies, insert appropriate punctuation, *etc.* If the composition process is split between two media and two individuals, the child no longer has complete control over the structure and content of

the story's final form.

4.3 sony card repeater

The Sony “Card Repeater” (Sony Corporation, 2001) is an interesting variant on tape-recorder technology. The system consists of a set of audio cards and a reader. Each card has a magnetic strip on one side and a picture or

figure 4-2:
sony's card
repeater



sentence on the other. When a card is placed in the reader, the audio encoded by the magnetic strip is played. In an abstract sense, the system lets users play segments of audio in whatever linear order they choose. Since the cards may also be ordered or arranged in a variety of configurations, users may be able to structure audio using physical representations.

However, users are unable to record their own audio and must rely entirely on pre-scripted content. Also, although users can spatially organize cards, playing a card involves separating it from any user-defined structure for play in the reader. Despite limitations, the system offers a simple and low-technology way of letting users – through two different interactions – organize and play segmented audio.

4.4 concept keyboards

The use of concept keyboards is advocated by the Irish Government's English Language Curriculum as a way of helping young children create stories before they are able to use traditional keyboards (Government of Ireland, 1999).

figure 4-3:
hands on
concepts/
concept
keyboard



A concept keyboard (e.g. Hands On Concepts, 2001) consists of a touch-sensitive pad which is subdivided into a number of areas. Each area can be linked to a word (or a series of words), a picture, a color or other concept. While each key on a conventional keyboard is linked to a single letter or other character, the concept keyboard will reproduce a whole word or phrase on a screen. This lets the child build a sentence or phrase from smaller components.

They also allow the teacher to predetermine the words or phrases assigned to each area of the keyboard using special overlays. The keyboard is sometimes

used to help children with mild language disabilities “author” by suggesting a certain linguistic units (Brown, 1987).

In a way, such systems do let young children create language-based artifacts but the basic content is still controlled by the system designer and not the child. By pre-linking content to a specific button, the designers prevent children from creating their own relationships between interface components and linguistic representations.

4.5 pets

There is an active research program to use technology to support children’s storytelling play at the University of Maryland, led by Professor Alison Druin. Druin and her colleagues have designed a number of interfaces for and with children focused on supporting children’s storytelling play.

figure 4-4:
the robotic
stuffed toy
used in the
pets system



One toy in particular is called PETS (Druin *et al.*, 1999), standing for Personal Electronic Teller of Stories. PETS lets children construct a story with computer-based software and then give a robotic stuffed animal certain

emotions and behaviors that correspond to parts of the story. Through a combination of screen-based and physical interfaces children are able to create stories that have physical instantiations.

Although a certain part of the system is “tangible” (the story’s contents are embodied in a physical object), to complete the entire composition process children must use a screen-based graphical user interface that is separate from the play environment. The emphasis of this system seems to be more on playing with a physical toy that represents a story, rather than on composing a story in a manner that supports the development of specific literacy skills.

4.6 kidpad

Druin and her colleagues also created a GUI-based story-construction system called KidPad (Benford *et al.*, 2000). Called “single-display groupware,” KidPad lets children collaboratively create narratives by making pictures that represent story “parts.” Children make links – and, the authors argue, stories – between different parts of the drawings by zooming in and out of their

figure 4-5:
during
storyplay,
children make
links by
zooming in
and out of
pictures



pictures.

The authors claim that this allows the creation of non-linear, complex structured stories and that the narrative structure arises from the child's zooming among the picture pieces. However, no evidence is offered to suggest that children's picture-linking is at all related to children's language-based story construction. Although this is certainly a creative exercise in which many children are able to generate and manage pictures, the authors do not present specific evidence that this activity is encouraging children's language development.

However, in support of Druin's claim, Berman and Slobin (1994) found that children's tended to be able to enumerate events or states if they occurred in contiguous picture frames. They cite this as evidence that young children are able to do certain kinds of sequencing and dividing that may be important for later language development. It is not clear whether this evidence applies to picture organization.

In relation to KidPad, Benford *et al.* make the assumption that "synchronizing shared interfaces" will encourage collaboration. But it is unclear exactly how this is supported. When an interface is screen-based users are able to manipulate the same virtual objects even though they may be located in physically separate places.

As the authors note, however, these spatially separate actions require that a central representation be synchronized and that all participants share the same view. When an object is embedded in a physical environment, spatially separate actions are not possible but there is no need to synchronize the

figure 4-6:
kidpad's
collaborative
drawing
interface



interface as it is physically shared between two co-located participants. This discussion is not meant to argue for the superiority of tangible versus graphical representations but merely to highlight that there are certain features of collaboration that are best supported by different interfaces.

Benford *et al.* also suggest that the “computer can provide a common frame of reference.” While it is unclear exactly what is meant by “frame of reference,” designers should be careful not to confuse the “computer” with the “application.” A physical object that simultaneously represents multiple applications – *e.g.* a desk-top computer – may be capable of multiple tasks but may also serve as a confusing physical “frame of reference.” A physical object with a somewhat limited set of functions and representations – *e.g.* a

single-purpose toy – may be limited in its use but may serve as a more consistent “frame of reference.”

Establishing a common frame that encourages collaboration is an active area of research. Benford *et al.* argue that children aged 5-7 (for whom their interfaces are designed) are at an age when it is especially difficult to collaborate. It is unclear exactly what literature supports this claim and what the features of collaboration are that children find especially difficult. (Recall that Garvey (1974) found that children engaged in focused interaction or mutual engagement during play on average of 66% of the session and that Preece (1992) found that children’s spontaneous stories involved collaborative telling approximately 70% of the time.) Although it is certainly true that children may collaborate with varying degrees of success in different circumstances, one approach is to design systems that allow either joint or individual play, letting children decide for themselves when to collaborate.

4.7 graphic story writer

Graphic Story Writer (Steiner and Moher, 1992) is a virtual environment that lets children manipulate multimedia objects. A rule-based story engine manages character and prop interactions, guides for story development and generates text. The story’s text is generated as children move objects on the screen.

The authors argue that their system helps children at the “emergent literacy” stage acquire language skills but it is unclear exactly what features of “emergent literacy” the system claims to support.

Although children are able to, in a sense, create configurations of multimedia objects, there is no explicit composition process being supported. Children create and manipulate multimedia objects that eventually cause a linguistic form to appear (text is generated that represents the location and trajectory of the objects) but the multimedia objects themselves have no linguistic properties. The text-generation facility is based on “story grammars” in which each story consists of a single setting and one or more episodes. The system uses a rule-based algorithm to determine what the “best” story is and ends the user’s turn when, by the system’s calculation, the central conflict has been resolved.

In this system, there is indeed “meaning-making” happening outside of the head but the language elements and the interaction path are neither linguistic nor are they completely under the child’s control.

The authors also claim that the adult can act as a transcriber to bridge the oral-written language “gap” and that an adult can ask supporting questions like “what happens next?” The prompting may definitely be beneficial but it is questionable whether adult transcription actually helps children acquire written literacy skills.

The authors compared their system to oral language generation. The control condition involved having children use a tape recorder and a paper-based screen-capture of the system's graphical user interface to create oral stories. The experimental condition had children use the fully functioning system. The authors claimed that the evaluation “demonstrates the relationship between illustrations and text, thus supporting emergent literacy” but it is unclear what specific aspects of language development the system supports. The great difference in stimulus materials between the control and experimental conditions makes any conclusions from this evaluation somewhat weak.

4.8 story isis

Story Isis (Kim, 1995) is a multimedia authoring tool created to let children manipulate videos, photos, drawings, texts, sounds and cartoons. The system uses a narrative metaphor to organize media content. It gives users explicit control over the placement and time duration of “media blocks” that are designed to represent story components.

The system is purely screen-based and has no tangible, non-GUI components. It supports branching, non-linear story construction and, unlike Graphic Story Writer, offers no rules on how these blocks should be structured. Instead, it provides an architecture within which users can control their own content organization. The system supports one element of

composition in that users always have complete control over the structure of their stories. A criticism stated by the author is that when the user runs out of screen room for the media elements, the interface can become confusing and unusable.

Like KidPad (Benford *et al.*, 2000), the authors do not consider the linguistic properties that describe a story, but instead focus on the design of robust algorithms that are able to support many different story configurations. While it is important to understand the computational properties of complex story-like data, this is a somewhat separate problem from the developmental linguistic goal of supporting literacy acquisition through story-construction.

4.9 neurosmith toys

Neurosmith (2001) is currently developing and marketing technology toys to help children compose music, experience foreign language sounds and learn new languages. Neurosmith toys are based on developmental linguistic research and change behavior in response to children's long-term play patterns – to a certain extent, “growing” with the child. One of Neurosmith's goals is to ground educational experience in engaging play. While the toys are certainly examples of innovative uses of technology and let children configure audio, they do not yet allow children to create their own content.

4.10 leapfrog toys

LeapFrog (2001) is another company developing toys to support children's language development. Their large product line provides "reading solutions" for children from birth to ten years old and concentrates on helping children acquire an awareness of phonetic, syntactic and discourse properties of language. Like Neurosmith, LeapFrog products aim to support children's language development through innovative use of technology within play contexts but do not yet allow children to have complete control over both the structure and content of their language.

figure 4-7:
leapfrog's
leappad toy



For example, LeapPad is an extremely successful LeapFrog product. Using a pen with a sensor in the tip, children are able to click on certain areas of special LeapPad books. When they click on words, children hear word sounds, explanations, synonyms, *etc.* The system is an excellent example of using non-intrusive technology to let children interact with linguistic representations in a learning-play context, but it does not yet support children's own language creations.

4.11 sam: the castlemate

Sam (Cassell *et al.*, 2000) is a system in which children tell stories with an embodied conversational character designed to be a “virtual peer.” Sam and the child share a castle as the common play space (the child’s half of the castle is physical while Sam’s half is virtual) and use common objects to narrate their storytelling.

When a child approaches Sam, the character greets the child and invites him or her to tell a story by taking a toy figurine from the shared castle.. While the child is telling the story, Sam provides verbal feedback (*e.g.* “uh-huh”, “really?”, “and then what happened?”) and non-verbal feedback (*e.g.* back-channel head-nods and eye-gazes that follow the location of the figurine) to encourage the child’s storytelling. When the child has finished telling the story, Sam takes the virtual copy of the figurine and tells a story to the child.

figure 4-8:
children tell
stories by
interacting
with a virtual
character and
a physical
castle



This system is designed to encourage children’s collaborative storytelling play

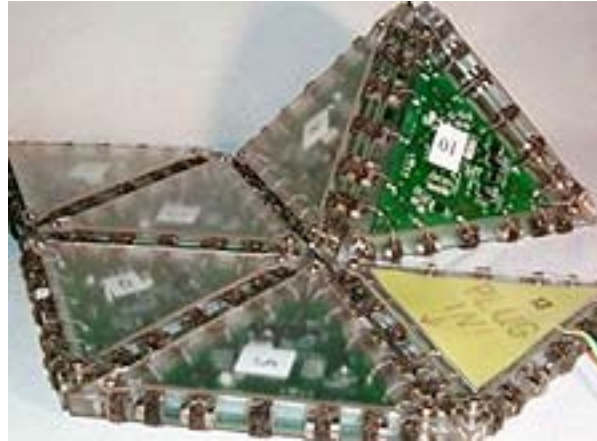
by providing an active listener – in the form of a virtual peer – for children’s self-generated stories. Sam acts as an audience for the child’s story so, in a sense, the language the child creates is not completely decontextualized. There is an audience present in both space and time. However, Sam does encourage children to express language and externalize meanings during storytelling play. The presence of a listening character seems to encourage children to make explicit language that would normally remain within the child.

4.12 triangles

Triangles (Gorbet, *et al.*, 1998) is a system that lets users manipulate digital information through physical interactions with segmented triangles. Each triangle represents a piece of digital content (*e.g.* a picture, a sound, a movie, *etc.*) and can be combined with other triangles to create larger structures. As users create physical structures by assembling triangles, the same configuration is represented on a screen-based interface.

Although Triangles is a simple and tangible way to organize data, it does not let users create and manipulate content away from a desktop interface. Although each triangle *represents* information, it itself does not *contain* any digital content.

figure 4-9:
triangles
lets users
create both
physical
and digital
structures



Also, to create digital representations, users must manage two different input and output spaces: the physical space in which the triangles are assembled and the configuration is determined and the virtual space in which the associated digital information is presented.

The triangles' form also inherently encourages non-linear and even three-dimensional structures. Although potentially entertaining branching narratives could be constructed with such an interface, the system is not designed to support young children's language development in a play context.

4.13 dolltalk

DollTalk (Vaucelle, 2001) is a system created at the MIT Media Laboratory's Gesture and Narrative Language Group. The project's goal is to help young children take different perspectives during storytelling play. The system consists of two stuffed animals, each fitted with an

accelerometer. When the child picks up the toy, the system records the child's voice. A principal assumption is that the child will be narrating a story segment (either in first- or third-person) that is somehow associated with that toy.

figure 4-10:
children use
dolltalk to
record stories
while playing
with stuffed
toys



For example, children often tell first-person stories by assuming the identity of an object they are moving as they narrate.

When children are finished recording their story, their audio recordings associated with each stuffed animal are played back while the respective toy vibrates. In a sense, the child becomes an audience for the story they just created. DollTalk encourages children to think about perspective taking, one of the decontextualized language skills thought to be important for later literacy (Wells, 1981; Hidi and Klaiman, 1984; Roskos, 2000).

4.14 animal blocks

Animal Blocks (Ryokai, 2001) was also developed in the MIT Media Laboratory's Gesture and Narrative Language group. Its goal is

to scaffold children's literacy acquisition by helping them make connections between oral and written stories.

figure 4-11:
Animal blocks
encourages
children to
mix oral and
written media



Children create their stories while playing with RF-ID tagged physical toys on a sensing surface. Children place objects at specific locations and record audio associated with that figurine. A virtual representation of that toy is then projected onto a physical book. A text box appears beside the virtual figure and children are encouraged to type words related to their oral story. By flipping the pages of the book, children can see and hear past stories.

The system encourages children to think about differences between oral and text as language media through interactions in which children generate their own language.

4.15 storymat

StoryMat (Cassell and Ryokai, 2000) is a system designed to support young

children's fantasy storytelling. The system consists of a large soft mat with various story-eliciting shapes and figures as well as a stuffed animal that

figure 4-12:
storymat acts as
a "listener" for
children's
stories



children use to narrate their stories. As children move the stuffed animal across the mat, StoryMat records the location and trajectory of the toy as well as the child's audio. In this way, StoryMat captures both the content of the children's oral stories as well as their play actions.

When a child places the toy over an area of the mat used during a previous play session, the child hears the other child's story while seeing a silhouette of the toy's move across the mat. Cassell and Ryokai found that children tended to treat StoryMat as a peer. The stories individual children told while using StoryMat (as opposed to a "passive mat" with no technology) were more complex and interrelated than stories they told independently. Also, the stories a single child told with StoryMat resembled the stories two children told on the passive mat.

figure 4-13:
two children
play on
storymat
together, using
a stuffed toy to
narrate their
stories



While the StoryMat system does not explicitly help children acquire literacy skills, it shows how technology-enhanced toys can be designed to scaffold children's storytelling play while still allowing children to create their own narratives.

4.16 conclusion

Many of the systems described in this chapter support certain aspects of children's story construction. Some, like KidPad and Graphic Story Writer encourage children's experimentation with visual forms intended to represent story elements. Others, like Sam and StoryMat, are designed to be "virtual listeners" to provide support and encouragement as children tell oral stories. Some are purely screen-based (like Story Isis and Graphic Story Writer) while

others (like PETS) sit at the boundary between graphical and tangible user interfaces. While the systems concentrate on different aspects of children's language play, they all attempt to help children develop language skills through fun and engaging activities.

Many traditional toys are also designed to help children develop certain literacy skills but without the aide of technological capabilities. As we consider the next generation of technology-enhanced language toys, it is important to consider which features of language they are trying to support and how these developmental goals are instantiated in specific features of the interface design.

In the next chapter, "Design," the iterative development of the TellTale interface is described. The goal of this design processes was to create a toy that would support the TellTale Composition Model and help children author oral stories in ways similar to how they will eventually construct written text.

5: design

5.1 introduction

The purpose of this chapter is to review the iterative design process that led to the final version of TellTale. The overall goal was to create a physical object that would support the features of the TellTale Composition Model. Specifically, the toy had to support children's oral language construction in a way that would be similar to how they would eventually compose written text.

As mentioned earlier, TellTale's development was not motivated by a fully formed composition model. Indeed, as design decisions were made, the composition model and the toy co-evolved. Although the composition model is largely based on current literacy literature, its development was also influenced by TellTale's iterative, user-centered design process.

In addition to the authorship guidelines, several other broad principles guided TellTale's development. First, it was important that the toy be able to

be used in a play context away from the computer. Second, children had to have complete control over both the structure and the content of the language they created. The toy was not to contain any pre-scripted content. Third, as much as possible, the toy was designed to be gender neutral. Finally, the toy was intended to be used either alone or in groups. Since children's play is often a collaborative experience – and since emergent literacy research stresses the importance of composing language in a social context – it was imperative that the toy support both solitary and joint activities.

The chapter describes the design process in chronological order. It begins with a detailed review of the motivation for designing a tangible toy and then traces the rationale for each prototype iteration.

5.2 why design a tangible toy?

It is quite reasonable to question why a technological tool for supporting children's oral language development should be tangible.

The rationale is that TellTale is intended to let children who are not yet able to read and write fully participate in a composition process. The design could therefore not assume that children were competent in any of the traditional literacy skills; *i.e.* the interface could not require children to read or write. But this requirement alone does not preclude designing a traditional

graphical user interface. The interface could have used pictures or other semiotic representations to encourage the same set of behaviors that TellTale supports.

The need for a tangible interface was primarily driven by the context in which children normally construct creative language independently, namely the play environment. Although this is not supported by any rigorous research or evaluation, the design was motivated by the following line of reasoning: children usually have the most freedom to create complex and imaginative language during storytelling; such storytelling play usually take place in a physical space in which children use objects to represent and mediate oral language creations. Therefore, it seemed reasonable to design a tangible toy that could be used away from the computer and that could be easily integrated into the context in which children's most creative and expressive language play takes place.

Another reason for a tangible design was to support the language-construction activities of all children, regardless of their socio-economic strata (SES) and familiarity with computers. Although their studies are preliminary, Christensen & Cosden (1986) and Kirkman (1993) found that children from low-SES tend to be less familiar with computers and that this lack of comfort results in poorer performance on academic tasks that require computer use. Since one of the research goals was to help children of all SES acquire written literacy skills through oral language play, it

was unacceptable to develop a technology that – through its interface – disadvantaged certain individuals.

There were other interface-related issues that motivated the design of a tangible toy. Specifically, the issues cited by Kim (1995) regarding limited screen size and Benford *et al.* (2000) regarding synchronization difficulties (see Chapter 3, “Related Systems,” for a complete discussion of these topics) suggested that a physical interface may make certain tasks easier for young children. Since social language play requires multiple children to have equitable access to an interface’s input and output mechanisms, a physical and distributed interface seemed to be the most promising approach. Some research (Kirsh, 1995) also suggests that when people use their hands to manipulate tangible objects they are better able to remember and organize information. Resnick *et al.* (1998) argue that digital manipulatives help children explore concepts previously thought to be too complex for their age.

Another reason for developing a tangible interface relates to some comments received from educators regarding difficulty teaching certain language concepts. (See Chapter 6, “Evaluation,” for a complete review of the interviews with teachers.) They said that certain concepts associated with stories (*e.g.* what a beginning, middle or end is, how a description of a character is different from a description of an event, *etc.*) are difficult to convey without concrete examples. Pontecorvo and Orsolini

(1996) highlight this issue saying that “when referring to oral discourse as ‘text’ we should not forget that in this case there is no physical object, but only a semantic content or set of linguistic forms made relatively stable by speakers’ memory.” Berman and Slobin (1994) found that children have a tendency to enumerate events and states if they occur in physically contiguous picture frames. They argued that these frames may help children refer to, organize and establish conceptual coherence among language segments. It was also hoped that TellTale’s physically separable segments would encourage children to think about what Garton and Pratt (1989) refer to as local coherence (*e.g.* within a TellTale body piece) and global coherence (*e.g.* across TellTale body pieces).

Children’s use of conjunctive phrases during TellTale recordings (described in detail in Chapter 6, “Evaluation”) suggests that children indeed used TellTale’s physical form to represent different language coherence relationships. Informal heuristic reviews (Art Graesser, personal communication) also suggest that TellTale’s physical structure successfully encourages children to represent and refer to linguistic segments. TellTale may give some permanence to Pontecorvo and Orsolini’s “oral text” and Berman and Slobin’s “frames.”

TellTale was also intended to be an object that would “listen” to children’s stories. Although the interface provides no explicit feedback (*cf.* Cassell *et al.*, 2000), its anthropomorphic form is designed to be a

rudimentary audience for children's storytelling. It was hoped that children might tell stories *to* and *with* TellTale and that the mere presence of the caterpillar character would elicit children's stories.

A criticism of this approach is that, by providing an object with even limited "listening" abilities, the interface is grounding the oral composition in a way not possible with writing. When composing text, the audience is imagined and the author is forced to "decontextualize" their language (Sulzby, 1996; Whitehurst and Lonigan, 1998). If children use TellTale as an audience, then the interface is, in effect, helping to "contextualize" language construction. The goal was to design an object that would encourage children to create stories but not give so much guidance to compromise the original goal of facilitating writing through oral composition.

A tangible interface was also thought to be more appropriate for a play environment. During early user testing, children would also often move around the room, making theatric gestures and incorporating other props into their storytelling. When many children were using TellTale they would often play in separate parts of the room and rejoin as a group to reassemble the story. It is unlikely that they would engage in such behavior while using a traditional desktop-based GUI. Several researchers (Walker, 1999; Roskos 2000; Pellegrini and Galda, 2000) emphasize that literacy tools should be freely available and integrated in the play environment. And the Irish Government's English language curriculum (Government of

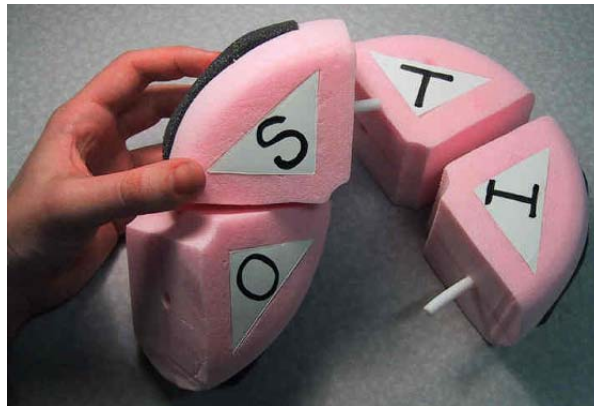
Ireland, 1999) lists “play and games” as one of the five contexts important for oral language development.

5.3 early design experiments

Early in the development process, several physical forms were created that began to investigate what types of designs may best let children create and structure language.

One early physical prototype sketch was “the pie,” shown below.

figure 5-1:
the “pie”
sketch
prototype lets
children
segment
language



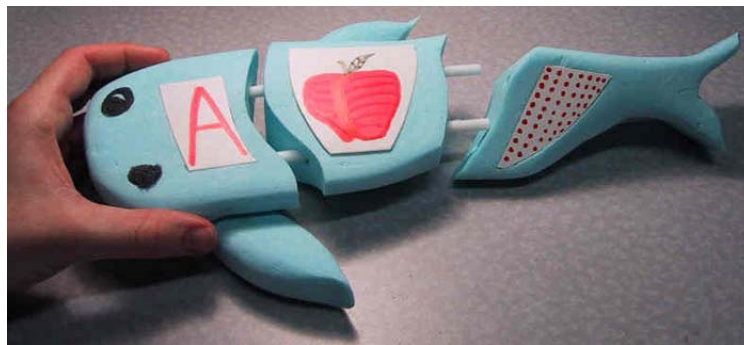
Its modular pieces were designed to let children embody and arrange digital audio using discrete components. Each body piece was designed to contain a speaker and an LCD screen. Through different physical arrangements, children could construct language that was either linear or circular.

To encourage children to create linear forms – the form that was thought to best represent written text – it was decided that a more organic design may

be appropriate. This idea led to the next physical prototype sketch, “the whale.”

While the whale only has three components and the physical form of each piece determines the order in which the whale must be assembled. Unlike the “pie,” this form defined a strict linear arrangement among interface components. *I.e.* each piece was a physical beginning, middle and end and each piece could never play a different role.

figure 5-2:
the whale
interface
encouraged
linearity
through
organic form



These two low-functionality prototype sketches led to the design of the first TellTale prototype.

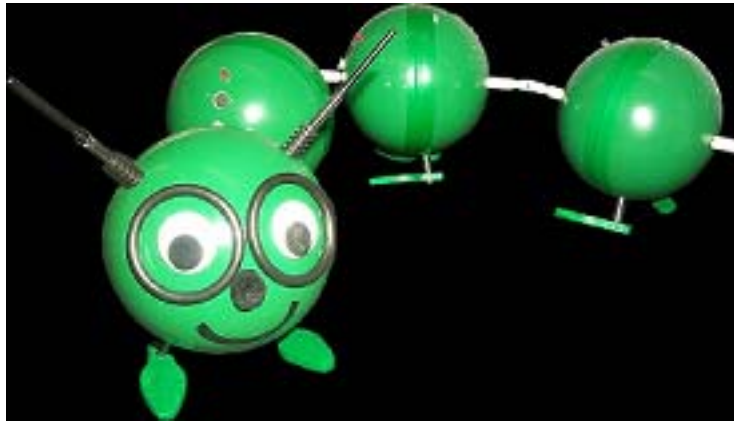
5.4 telltale version 1.0

As the earlier explorations suggested, the first version of TellTale was designed to be linear and modular. Unlike the “pie,” this first version of TellTale used an organic form to convey a strict linear sequence but, unlike the “whale,” there was no hierarchy among the units. There

was a single head piece to indicate the caterpillar's – and the story's – physical beginning but all other pieces were identical in functionality and appearance.

This version also contained more functionality than the earlier prototype sketches. Using TellTale Version 1.0, users could record 20 seconds of audio

figure 5-3:
the first
telltale
prototype let
users record,
but not
cascade,
audio



into each body piece and could play back each body piece individually.

(The choice of this duration of audio was not based on any explicit design rationale or any psychological theory related to children's auditory memory. At the time, it was simply the most accessible and easily modified circuit board available with a reasonable amount of recording time. As is discussed in Chapter 6, "Evaluation," this somewhat artificial duration may be inadvertently related to children's working memory abilities while playing with TellTale.)

Each body piece contained an off-the-shelf audio playback and recording

circuit board with embedded memory and inputs for a microphone and speaker. However, there was no communication between body pieces. To hear an audio sequence, users had to press play on each individual body piece. This was problematic for two reasons.

First, the fundamental goal of the design was to help users establish coherence between story units using *language*. By requiring users to press play on each individual piece, users could play the story in whatever order they wished. Any continuity present in the story's language (*e.g.* how users chose to end or begin each segment of audio) was interrupted by requiring users to, in effect, re-start the story for each body piece.

Second, there was no *functional* reason to assemble the caterpillar. Although the toy's form suggested that the pieces be assembled, there was no reason to do so. The pieces had identical functionality, whether they were together or apart. This seemed to make the play experience much less engaging and did not afford the physical construction of continuous language, a central aspect of the research's goal.

In this version of the prototype, each body piece was green. While this gave the toy a more uniform appearance, it made it difficult to distinguish between body pieces. Users often forgot what body piece contained what audio.

In this (and all) versions of TellTale, there is a head piece but there is no

explicit tail piece. The tail is simply the body's last piece. Although it may have better encouraged children to create story endings, the decision was made to make all body pieces functionally identical and interchangeable. One motivation of this decision was to give children the option of rearranging body pieces and putting the story's ending at the beginning. (Many children did this.) This was a compromise, though, as an explicit tail may have encouraged children to tell stories that contained better endings.

This version of the interface was also extremely fragile. The caterpillar's legs were made of weak wood, the play and record buttons constantly malfunctioned and the connections between pieces often broke.

Although no formal user studies were conducted with this prototype, several informal evaluations with children indicated that many changes needed to be made for the next iteration. The body pieces should communicate with each other; there should be some way to play the entire story with one action; there should be some way to visually distinguish among body pieces; and the prototype should be robust enough to withstand prolonged use by children. This last task was perhaps the most daunting.

5.5 telltale version 2.0

The next version of TellTale was designed to let children better structure their audio. Through colored and communicating body parts, it was thought

that children may start to use properties of the interface to structure cascading story segments. This version was also designed to be robust enough for testing.

Like the previous version, users could record and playback 20 seconds of audio with each body piece. (The off-the-shelf sound boards used in the first version functioned reliably and there was no theory- or evaluation-based reason to design new audio hardware.) However, users could also connect the pieces in a row and, by pressing play at any point in the sequence, hear the audio cascade linearly through the caterpillar.

figure 5-4:
version 2 of
telltale was
designed to
let children
organize and
play their
stories more
easily



In this version, the head piece contained a single button on the caterpillar's nose. When users pressed this button, the piece directly adjacent to the head would begin playing. The head was made functionally different from the other pieces to see whether, when in a group, children would use the head piece to indicate that the story was finished or ready to be presented.

Children could not record any audio into the head piece; it was merely used to start the audio cascading. Indeed, as described in Chapter 6, children often viewed attaching the head piece as the final act of composing. The child with the head piece would sometimes act as a self-proclaimed “publisher.” Instead of recording their own content, publishers seemed to play at a meta-level, monitoring how the story was progressing. In a sense, the caterpillar’s physical form was completed when the story was completed.

To help users follow which body piece was playing, an LED was added that would briefly light at the end of the audio. (For several reasons, this design was inadequate and was addressed in the next version.)

figure 5-5:
children can
play body
pieces
separately or
as part of a
larger telltale



To enable communication between body pieces, a simple circuit was designed. First, to avoid re-engineering the stable off-the-shelf playback and recording hardware, a feature of the existing circuit board was “hacked.” After each body piece finishes playing, a +5V signal causes an LED to light. Since this signal indicates that a given body piece’s audio had finished, it is

the perfect signal to use to tell the next body piece to play.

figure 5-6:
children
physically
connect body
pieces to
organize their
stories



To summarize, after users play a body piece, the +5V signal is sent to the LED. If there is another body piece attached to that one, +5V is sent through a standard mono audio cable to the next body piece. This signal is then used to start playing this next body piece.

The decision was also made to retain both play and record capabilities in each of the body pieces. One suggestion was to let children only use a body piece to record and require them to attach the head to hear the piece's audio. Such a design would make collaborative play difficult as each child would be competing for the head piece to hear their recordings.

In this version, each body piece – with the exception of two red pieces – was a different color. The intention was to make it easier for users to distinguish between body pieces without having to play the audio. Subsequent user testing confirmed that the colors made it easier for children to refer to and differentiate among different recordings.

The decision to make two of the pieces red was an informal experiment. Since one of the main goals of the research was to let children organize language with a physical interface, I was curious whether children would use characteristics of the interface itself as a method of structuring their language use. Although this issue was not carefully studied, children would often join the two red body pieces, saying things like “these two go together.” In effect, a simple interface characteristic seemed to be helping children organize their audio.

This prototype was also much more stable than the previous version. The body piece legs were made of malleable plastic, the record and play buttons functioned more reliably and, generally, the entire toy was more robust. This was the version used for all user studies and, although it often required minor repairs, it generally withstood children’s repeated and sometimes brutal use.

During testing, there were several problems noted as children used this version of TellTale. First, very young children (some session participants were as young as 3-years old) had great difficulty using the record button. To record, users have to hold down a button. Although a light appears indicating that TellTale is recording, many children forget to look at the light. Their finger accidentally slips off the record button without them noticing. This was incredibly frustrating, causing many recordings to be lost (and one child to cry ☹).

Children also frequently dragged TellTale along the ground, pretending it was a train. The design of the body piece legs made this movement difficult and many children suggested that the caterpillar instead have wheels for legs.

A more serious problem was that, when the body pieces were played as a connected sequence, children found it difficult to follow which body piece was playing. The LED that appeared at the end of each recording was too small and too brief to orient the children's observations. This, too, was addressed in the subsequent design.

5.6 telltale version 3.0

The final version of TellTale retained many characteristics of the first and second versions but also contained new features designed to address several usability problems. A picture of one of the body pieces of TellTale Version 3.0 is shown below.

In this design, the top of each body piece is a translucent half-sphere and the bottom is an opaque, colored half-sphere. The two pieces are joined with a single hinge that also contains wires to enable communication between the two halves. Upon opening the body piece, users see a darkly stained wood platform. Embedded in the platform is a circular array of green LEDs and a

figure 5-7:
in the third
version of
telltale,
children put
their audio
"inside"
body pieces



single red LED. The center of the platform is also perforated and contains a counter-sunk combined microphone-speaker.

The use of this body piece is quite different from the previous version. To record a piece of audio, users open the sphere. Upon doing so, the red LED lights and recording begins. When users are finished recording, they close the sphere and recording stops. In a sense, users put the audio “inside” the sphere. This design change was made to help younger users record; it was thought that opening a ball might be easier than continuously pressing a button.

When users want to play a body piece, they press a green button on the outside of the top half-sphere (while the entire body piece is still closed). There are small perforations in the top half-sphere that let the audio – coming from the counter-sunk speaker/microphone in the bottom sphere – be heard through the plastic. Also, the array of green LEDs on the bottom sphere light with a brightness proportional to the amplitude of the audio. If users record loud sounds, they are played back with an accompanying bright green hue; if users whisper, a soft glow appears during playback. This design change was made to let users better follow audio as it cascades through the caterpillar.

Wheels were also added to the bottom of each body piece to let users more

easily drag TellTale along the floor.

Unfortunately, this prototype was not robust and was not completely implemented. The intricate details of embedding the LED array and the speaker-microphone and of establishing reliable electronic communication between the two half-spheres made it impossible to complete this prototype in time for user testing. It is also very likely that this prototype would have been too fragile to withstand repeated use by young children. The hinge mechanism, for example, was difficult even for adults to use.

But this last iteration of TellTale represents several important progressions in the development. The hatch-shell design proves to be a very promising way to let young children use TellTale. The translucent glow of arrayed LEDs seems to be an aesthetically pleasing way to help users orient audio to a body piece. And the wheels, although a minor feature, let children use the toy in the way they had wanted to since the first version.

5.7 conclusion

In this chapter, TellTale's design process was reviewed. However, it would be inaccurate to say that TellTale's development proceed through a series of independent steps that rested on a fully formed theoretical model. The TellTale Composition Model described in Chapter 3, "Literacy Theory," often developed in conjunction with the design process and user evaluations.

It is also important to remember that, although TellTale was designed to support the TellTale Composition Model, other designs may better support all features of the model.

For example, all the designs described here emphasize *linear* representation of oral language. Although children could record audio in any order, the only physical form possible was a linear ordering that was thought to be most like the linear ordering of written language. The composition model merely advocates supporting children's ability to structure and organize their own language. It does not explicitly state that linear segmentation is required and, indeed, different physical configurations may be possible. See the designs discussed in Chapter 7, "Future Work," for more details.

In conclusion, TellTale's design followed an iterative user-centered approach. At each stage of development the prototype's usability was evaluated with children. Each design decision was made to address either a usability issue or a conceptual challenge associated with the fundamental research question: how does a toy that lets children compose oral language help them acquire skills that will help them eventually author written text?

6: evaluation

6.1 introduction

This chapter has two main goals. The first is to explain the evaluation strategy used to guide the TellTale user testing. The second is to explain the results of a series of tests that address specific features of the TellTale interface and children's language play.

To help frame the evaluation strategy, it is worth briefly revisiting this thesis' central claim. The hypothesis is that a tangible, technology-enhanced toy that supports oral story-construction can help children acquire certain skills that are important for later written literacy. To evaluate this claim, its constituent parts must be carefully analyzed.

The claim argues that an interface (*i.e.* the tangible toy) can have an effect on a cognitive process (*i.e.* the TellTale Composition Model, which is based on emergent literacy research). Although evaluating the usability of an interface is often a separate problem from evaluating the effect of the toy on a

cognitive process, the TellTale evaluation strategy attempts to address both aspects of this claim.

The evaluation consisted of three empirical studies and a series of structured interviews with teachers. The studies investigated how children used TellTale to create oral stories and how this story-construction was similar to written authorship. The structured interviews focused on how teachers might integrate TellTale into existing language curricula.

The first step of the evaluation process was to conduct a preliminary pilot study to identify general issues associated with children's storytelling behaviors and their use of the interface. These investigations helped define the protocol and identify the hypotheses used in subsequent studies. Two more targeted studies were then conducted, each of which addressed a specific aspect of TellTale's interface design and theoretical motivation.

The second study evaluated the impact of segmented interface components on children's ability to plan and coherently link story pieces. The purpose of this study was to determine how children's use of the interface (to plan and join story content) changed when one of the interface features (its segmentation) was altered. This study also offered an unexpected insight into one of the application domains described in Chapter 3, "Literacy Theory": how children with language learning disabilities construct stories.

The third study evaluated how well TellTale supports children's collaborative storytelling as well as how children established narrative coherence during a joint authorship task. The purpose of this study was also to determine how well TellTale helps children practice two features of the TellTale Composition Model: reflection and sharing. Since emergent literacy theory states that children develop language skills at least partially through collaborative storytelling, it was critical to determine how TellTale supported this behavior. This study was also an opportunity to address the other application domain described in Chapter 3, "Literacy Theory": how children of different socio-economic strata construct stories.

Unfortunately, not all aspects of both the interface and the theory on which its design was based could be evaluated within this thesis. Instead, the evaluation strategy attempted to concentrated those aspects of the interaction (supporting collaboration, enabling coherent story construction) thought to be most relevant to both the interface design and the emergent literacy theory.

The remainder of this chapter describes the three studies and the structured interviews. For each of the studies, the following are discussed: the empirical hypotheses; the participants' characteristics; the experimental protocols used; the data collected and the analyses conducted; the findings and conclusions; and a description of future work to address outstanding hypotheses. Each study is also critiqued for possible problems with the hypotheses, protocols,

participants and analyses.

6.2 the first study: a pilot

This study had four main goals. First, although TellTale was designed to support children's oral story-construction, it was unclear exactly how and why such an interface would impact children's language development. A set of hypotheses needed to be developed that would address both the features of the interface and the emergent literacy theory on which its design was based. This pilot study was guided by no clear interface- or language-use hypotheses. Its primary purpose was to ensure that future studies would be better designed and informed.

Second, it was unclear for which age group TellTale was designed. The emergent literacy literature describes children's general language behaviors across different ages. But during the design process I failed to determine which children would find TellTale engaging and how exactly TellTale's interface was relevant to specific language development issues. This pilot study was designed to survey a broad range of ages with the goal of narrowing the demographic focus of future designs and evaluations.

Third, it was unclear exactly how children's stories should be elicited. Since the interface was designed to be a story-construction tool, it was important that children be encouraged to use TellTale to create stories. However, it

was also critical not to make the instructions so strict that the tests would miss unanticipated uses of the interface. Also, since TellTale was designed to study how children organized their story components, it was important to provide an experimental stimulus that encouraged structured storytelling without explicitly telling children what structure to use.

Fourth, although the interface was designed to be robust enough to be used by children of various ages, it was unclear whether the prototype could withstand the harsh manner in which children normally play with their toys.

6.2.1 Method

With these four goals in mind, the first pilot study was conducted during Summer 2000 at the MIT Media Laboratory. Twenty-six children from 3 to 10 years of age played with the second iteration of TellTale under two different conditions: solitary play (17 children were in this condition) and group play (with two or more other children of a similar age they knew well; 9 children were in this condition). The children were recruited on the MIT campus and most were sons and daughters of graduate students, professors and staff. No attempt was made to establish a baseline level of language ability although all children were native English speakers. All sessions were video- and audio-taped and later transcribed by the experimenter.

The session began with the experimenter giving the child(ren) a short introduction to the TellTale interface. After explaining how to

use the toy, the child(ren) and the experimenter made a story together. Participants were then left alone and asked to tell as many stories as they could. (Three of the younger children were not comfortable being left alone and played while a parent was in the room.)

To address one of this study's goals, stories were elicited using different methods. Some children were asked to based their story on a series of pictures (the famous "frog story" sequence often used to elicit narratives in developmental linguistic studies (Berman & Slobin, 1994)) and others were asked to tell a story suggested by the experimenter's description of a physical play setting (a green mat and foliage described as the forest TellTale lived in). All children were also given the option of telling a story of their own creation instead. The table below summarizes how various children's stories were elicited.

table 6-1: description of pilot study participants

Story Elicitor	Number of Children	Ages	Genders
Frog Story	13	2 x 5-year olds 3 x 6-year olds 3 x 7-year olds 4 x 8-year olds 1 x 10-year old	8 females 5 males
TellTale's Forest	6	3 x 4-year olds 1 x 5-year old 1 x 8-year old 1 x 10-year old	2 females 4 males
Child's Own Context	7	1 x 3-year old 1 x 5-year old 5 x 7-year olds	4 females 3 males

6.2.2 features of children's play with telltale

Although the broad age span of users does not allow for statistically significant results, examination of the transcripts and video data suggest interesting features of the children's interaction with the toy and the types of stories they told.

TellTale's discrete body pieces seemed to encourage children to segment and organize audio. The finite amount of audio contained in each piece seemed to help users plan what audio they should use to convey story meanings. The analysis of children's audio focused on how they used TellTale to segment and organize their stories, and how they mapped narrative organization to individual body pieces. The most interesting findings indicated that TellTale elicits stories from children that very strongly resemble those they tell in natural environments. And yet, TellTale also seemed to encourage them to think about the nature of text organization, the granularity of the text unit and the mapping of word to story.

6.2.2.1 *cohesive language*

Stories are made up of descriptions of events that are linked to one another causally or temporally. Take, for example, a simple story such as "we spent weeks preparing for children to come into the lab and then the dog ate the TellTale prototype so we were crushed. But we got over our distress and the next week we built a new TellTale." Each of the story events

(preparing for children, the dog eating TellTale, us being crushed) is linked to the others using connectives: “and then”, “so”, “but”, “and the next week”.

The analysis of children’s audio focused on the kinds of words children used to connect their stories. Specifically, it investigated whether there was any relationship between the linguistic features of children’s recordings and how they used TellTale. Special attention was given to the kind of language children used at TellTale body piece boundaries (*i.e.* how they chose to begin and end recordings) and whether this was indicative of any strategies children used to establish coherence within a story. There were not enough data to support an analysis of the stories children produced in the group play condition so all observations concerning cohesive language use apply only to the solitary play condition.

figure 6-1:
a five-year
old using
telltale



The language younger children used at body piece boundaries tended to fall into one of three categories: no conjunctive phrase (*i.e.* there was no attempt to tie the beginning of one piece of audio to the audio of the preceding or

succeeding body piece); the simple coordinating conjunctive “and”; and repeating a previously mentioned noun phrase (*e.g.* one 4-year old consistently introduced each body piece with “the elephant ...”).

Unlike the simple conjunctives used by younger children, older users tended to use more complex subordinating conjunctions and adverbial phrases like “the next day ...”, “after he had breakfast ...” and “suddenly ...” to link audio across body pieces.

Many older children also often used pronouns (*e.g.* “he”, “her”, “they”) at the beginning of body pieces to refer to previously mentioned characters. Younger children very rarely used pronouns (or any other kind of anaphora) anywhere in their stories.

This use of referring expressions (noun phrases and pronouns) and connectives (“and”, “the next day”) is absolutely consistent with what has been described in many studies of children’s acquisition of narrative language (Berman and Slobin, 1994; Karmiloff-Smith, 1981; Nippolo, 1998) and indicate that children did not have to be taught how to use TellTale to construct stories.

6.2.2.2 *telltale structure, story structure*

TellTale also seemed to affect how children reflected on their story language

and how they experimented with story structure.

Participants were told that they could tell as many stories as they wanted with TellTale. Many children told several different stories, while a number of children told roughly the same story, but structured it differently in each re-recording. This was particularly true of children in the 6-8 age range, corresponding to the age when children are beginning to learn about text and about writing. Four stories recorded by one 6-year old illustrate this pattern and are shown in Table 6-2.

The first story this six year old girl recorded is a complete and coherent narrative. She only used two of the five available body pieces, saying she “didn’t need the other ones.” In her next story she used all five body pieces but chose to put shorter story segments in each. The third and fourth stories were recorded in response to a question the experimenter posed about why she liked or disliked TellTale. She responded that she “likes TellTale a lot because you can split things up in different ways – see?” and then proceeded to make the third story – in which she predominately recorded a single word into each body piece – and the fourth story – in which she recorded a single *clause* into each body piece. Note that the fourth story is based on the third but conveys much more information (*e.g.* the unicorn is named and described).

table 6-2: four stories recorded by a six-year old using telltale

	Body Piece	Body Piece Audio
1 st story recorded	1	Once upon a time there was a little boy who was sleeping. The next morning he lost his pet frog. Then he went looking and ... [with rising intonation]
	2	He looked in a hole and the dog looked in the beehive. He looked I think under a rock and an owl flew over. And then he was calling his frog's name. He fell into the river. He was looking and he said "shhh". Then he found his frog. The end.
	3	<i>Did not use</i>
	4	<i>Did not use</i>
	5	<i>Did not use</i>
2 nd story recorded	1	Once upon a time there was a unicorn. And he was so pretty.
	2	And when he touched its horn a jewel came. And he touched anything and a jewel came
	3	And then it lay and it wanted me to get on its back.
	4	Then I rode to its castle.
	5	And saw a real live princess. The end.
3 rd story recorded	1	Once
	2	Upon
	3	A
	4	Time
	5	There was a unicorn.
4 th story recorded	1	Once upon a time
	2	There was a unicorn
	3	Named Crystal
	4	And she liked to play hide and go seek with people. And she was a good person.
	5	The end

6.2.2.3 dialogue construction

Younger children who were in the solitary play condition often used TellTale

to record both sides of a conversation instead of recording a more traditional narrative. For example, one 5-year old child used TellTale to construct the following dialogue, taking both sides of the conversation herself:

table 6-3: a five-year old using telltale to take both sides of a conversation

Body Piece	Audio
1	[deep voice] Say, why, why do you always keep talking about mice?
2	[high voice] I keep talking about mice because that is the only thing I like.
3	[deep voice] I think you're crazy if you keep talking about mice. You are crazy.
4	[high voice] I think we should all calm down and sit down.
5	[high voice] And besides, our conversation is over.

This child assumed two different roles within a single story, narrating the first-person role for each side of the dialogue and effectively “contextualizing” part of the narrative by simultaneously taking two different perspectives: that of the speaker and that of the listener. Hidi and Klaiman (1984) suggest that certain kinds of dialogue transcription may help children transition from oral conversation to written text creation. In effect, some children used features of TellTale to practice skills that will eventually facilitate text authorship.

6.2.2.4 *group play*

A total of 9 children in three groups played in this condition. The first group

consisted of four girls all 7-years old and all from the same classroom participating as part of a school trip. The second group consisted of three brothers aged 3, 5 and 7; the third group consisted of two 8-year old twins.

Although there are not enough data to support any claims about children's collaborative language play, the group observations suggest that TellTale is an engaging and social interface when used by more than one child.

figure 6-2:
eight-year
old twins
playing
together
with telltale



Across all groups, children worked together to build stories, each child taking responsibility for a single body part and usually alternating turns with another child. (In the first group one girl also assumed responsibility for TellTale's head piece and called herself "the publisher.") Children debated about what exactly should be recorded in each body piece and sometimes used the fifth body piece to record, in unison, their names as the authors. In the first group, at one point the story became complex and there was much debate over exactly what should be said in the fourth body piece. One child wrote with a crayon on a piece of paper exactly what she thought should be said –

“so we’ll know for sure” – indicating that these children were comfortable mixing written authorship with oral storytelling during the play session.

6.2.2.5 *editing: telltale as a “story processor”*

In most cases, younger children who were playing alone did not make repeated revisions or edits using a single body piece. They tended to record into a body piece, listen to its audio both individually and as part of the larger caterpillar and then leave it alone for the rest of the session. Only older children often re-recorded audio content and changed body piece configurations.

When children were asked what would happen if TellTale pieces were in another configuration, several younger children responded that “it just wouldn’t sound right” and “would make the story wrong.”

In one of the group play sessions, a 5-year old child creatively used TellTale to copy audio. After recording into four of the five body pieces, he expressed concern that there was only one body piece remaining. His 7-year old brother then held down the record button on the fifth body piece while playing back the first four in sequence, in effect “copying” the audio of the first four body pieces into the fifth and freeing four body pieces. It was interesting to see children using the interface in such an unanticipated way, suggesting that TellTale’s flexible and underdetermined interface encourages

creative uses.

6.2.3 summary

The pilot study was extremely useful. First, it helped determine exactly how to elicit stories in future sessions.

Although the Berman and Slobin (1994) frog story is an excellent method for eliciting children's segmented production of language, it seemed to interfere with the very phenomenon being investigated in this study. Namely, children sometimes associated an individual picture with a specific TellTale body piece and would merely record a description of the image into the body piece. This pre-defined organization made it difficult to determine exactly why children were using different body components to record different story pieces. It was also difficult to tell whether the interface was affecting how children chose to structure narratives.

However, when children were asked to record their own story with no stimulus material, they seemed to find it difficult to start making a narrative. The physical forest context offered an excellent compromise between the highly structured frog-story elicitor and the open-ended request with no stimulus. The forest seemed to provide a space and set of props that children could use to help stimulate their storytelling. (Like StoryMat (Cassell and Ryokai, 2000) the forest context seemed to offer a play space

that was underdetermined enough to let children create and structure their own narratives.)

The pilot study also showed that the TellTale prototype was indeed robust enough for prolonged user testing. Although certain aesthetic features of the prototype required frequent repair – the antennae kept falling off – this second version of TellTale survived well enough to be used in subsequent user studies.

This study also suggested a number of hypotheses related to both the TellTale interface and the theory on which its design was based. Specifically, children seemed to use TellTale to construct stories that contained conjunctive phrases and other connectives. Furthermore, these coherence techniques (both verbal and non-verbal) seemed to occur at body piece boundaries, suggesting that the interface's structure helped children organize their stories. This was considered to be an interesting area for future investigation and motivated the second study that manipulated one feature of the TellTale interface – segmentation – to determine the effect of distributed body pieces on how children constructed stories.

Unfortunately, the pilot data on group play were inadequate to make any strong claims about how the interface influenced group authorship or the kinds of stories children produce collaboratively. Children did seem to enjoy using TellTale in groups, suggesting that there may be specific features of

TellTale that encourage certain aspects of collaborative authorship. These observations motivated the third study that specifically investigated the strategies children of different socio-economic strata used to establish coherence during joint authorship.

This preliminary study also suggested that TellTale was best suited for children aged 5 to 7 years of age. Younger children found the interface difficult to use and the task hard to follow. Older children often had advanced written language skills that eclipsed TellTale's oral language features. (Although it is somewhat comforting to note that children of all ages found novel and age-appropriate uses for the interface. One 3-year old consistently chewed on the antennae and one 10-year old seemed to record a soap-opera plot.)

Generally, the pilot study was an extremely useful way to determine what empirical questions should be asked in the future, how children's stories should be elicited, for which age group TellTale was most appropriate and whether the prototype was robust enough to withstand prolonged use.

This pilot study was also the inspiration for version 3 of TellTale. It was sometimes hard for some participants (especially younger children) to manipulate the record and play buttons, making story-construction difficult. As explained in Chapter 5, "Design," version 3 of TellTale has no record button. Instead, users open the body pieces to start recording.

Unfortunately, this prototype proved to be too fragile to use in subsequent user tests. All evaluations described in this thesis were conducted with version 2 of TellTale.

6.3 the second study: evaluating segmentation

The next study (also described in Ananny and Cassell (2001)) was conducted to evaluate how a TellTale with segmented body pieces – as opposed to a TellTale with only a single body piece – affected children’s story-construction.

The pilot study data suggested that children used TellTale body pieces to represent story elements and that they used language to establish coherence between physical body pieces. The goal of this study was to better understand how these oral constructions may be related to written authorship.

6.3.1 method and data analysis

In this study, children used one of two TellTale prototypes. The first, called *Segmented TellTale (STT)*, was identical to the prototype used in the pilot study as well as the third study. This prototype consisted of a single head piece and five body pieces, each of which could record and play 20 seconds of audio.

The second prototype, called *Unified TellTale (UTT)*, consisted of a single

body piece with the ability to record and play back 100 seconds of audio. The two prototypes let children record the same total amount of audio but, in the case of STT, the audio was segmented into physical interface components. This study was in part designed to determine how a segmented toy like TellTale differed from more traditional objects (like tape recorders) for recording and playing back audio.

The study was conducted in January 2001, partly at the MIT Media Laboratory and partly at a local Cambridge after-school program. Fourteen children (aged 5,1 to 7,4) participated in this study. Each child was videotaped in one of two different conditions: the *Unified TellTale* (UTT) condition (n=8; ages 5,6 to 6,10; 5 female, 3 male) or the *Segmented TellTale* (STT) condition (n=6; ages 5,1 to 7,4; 5 female, 1 male). Although no attempt was made to determine the children's baseline language skills, all participants were native English speakers.

In both conditions, children played alone with the respective version of TellTale for approximately 20 minutes. Children were assigned randomly to use either UTT or STT. Stories were elicited by having children narrate either the traditional "frog story" (in the segmented condition), a scene described by the experimenter (in the unified condition) or a story of their own choosing (offered for both conditions).



(Although the UTT elicitor differed from the STT elicitor, it is not

anticipated that this affected the study’s results. An analysis of all stories revealed that children in the STT condition did not structure their stories using the organization represented by the arrangement of the frog story pictures.)

The video for each child was transcribed and analyzed for: length of story in words; length of story in time; disfluencies; conjunctive phrases; presence of canonical beginning/ending phrases; and the composition process.

Sample stories told with each TellTale are in the table below. The stories illustrate how narratives told with STT contained fewer false starts and more conjunctions than those told with UTT. The samples also show how stories told with STT had better-formed beginnings and endings. These findings are discussed in detail in the results sections.

table 6-4: sample stories told with the segmented and unified versions of telltale

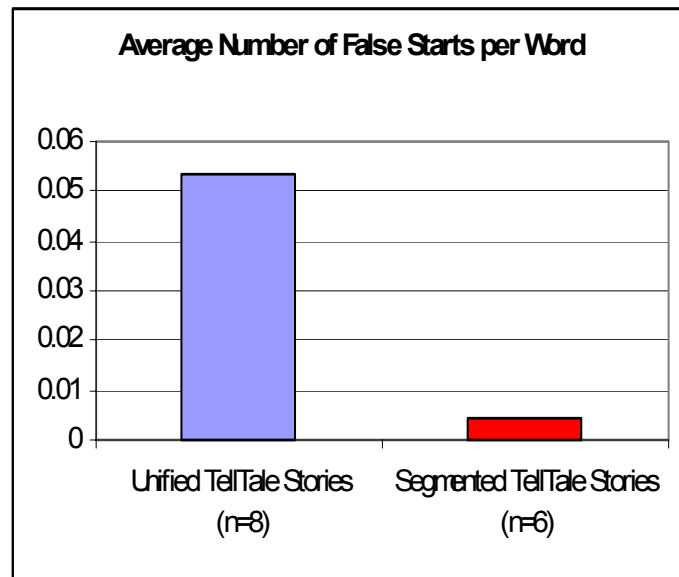
 <p>Segmented TellTale (told by a child aged 6 years, 9 months)</p>	 <p>Unified TellTale (told by a child aged 6 years, 7 months)</p>
<p>BP#1: “Once upon a time there was a caterpillar.”</p> <p>BP#2: “Who once went into the forest one day.”</p> <p>BP#3: “And the caterpillar got lost.”</p>	<p>“The caterpillar had just got home. He didn’t know where he was. He asked the horse where his mother was. The horse said ...said he was ... she was ... at ... the ... leaves she ... it ...</p>

BP#4: “And found a talking pine cone.”	she said ...”
BP#5: “And that pine cone helped him find ... find his way back. The end.”	

6.3.2 quantitative results

Stories told with *Segmented TellTale* (STT) had fewer false starts than those told with *Unified TellTale* (UTT) indicating that the segmented body pieces let children plan their utterances off-line.

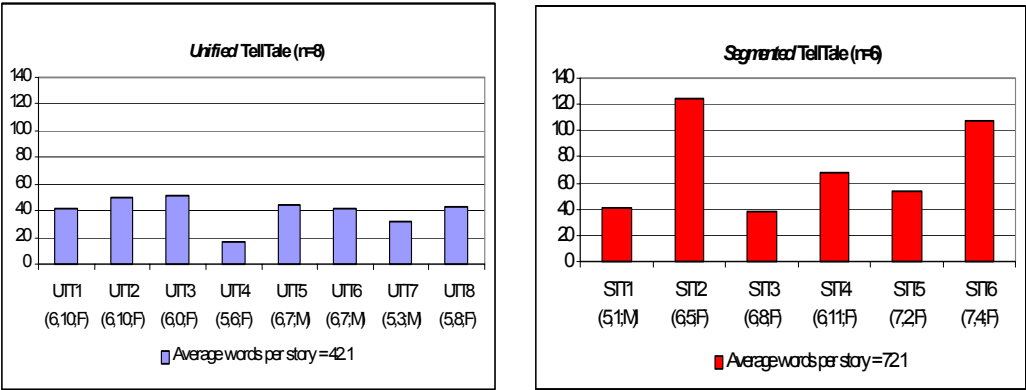
figure 6-3:
telltale's
segmented
structure seems
to help children
plan their
utterances



Stories told with STT were also longer than those told with UTT: STT stories were an average of 72 words per story and 40.5 seconds per story whereas UTT stories were an average of 42.1 words per story and 34.2 seconds per story. These data indicate that the segmentation may afford recording longer, more cohesive stories.

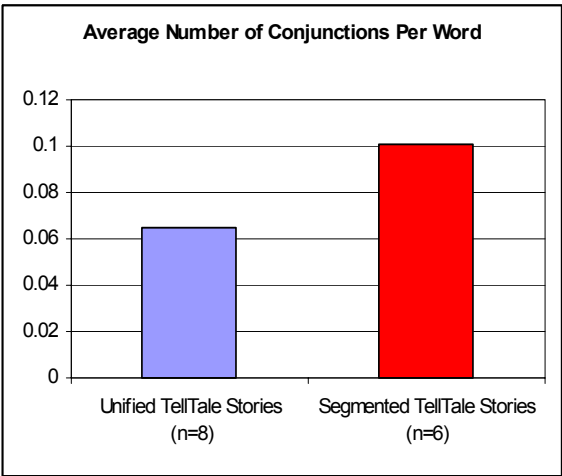
The tables below show the average length of each child’s story, separated into the STT and UTT conditions.

figure 6-4:
children
using
segmented
telltale told
longer
stories



Stories told with STT also had contained more conjunctive phrases (and, then, however, when, while, after, later, so, therefore, one day) per word than those told with UTT.

figure 6-5:
telltale’s
segmented
structure
seemed to
help
children link
story pieces



And when conjunctive phrases did occur in STT, they tended to occur at

body piece boundaries, indicating that children treated body pieces as story units, linking them with connectives.

6.3.3 qualitative results

6.3.3.1 *composition process*

Children's process of creating and editing stories was also analyzed in both the *Unified TellTale* (UTT) and *Segmented TellTale* (STT) conditions. Generally, children who used UTT recorded only one story and children who used STT recorded several stories. Children using UTT sometimes revised their story but, when they did, they tended to repeat entire sentences and phrases. Each revision contained only minor edits. Children using STT often revised individual body pieces extensively and played their stories at many different stages of (physical) completion.

6.3.3.2 *beginnings and endings*

In both UTT and STT conditions children tended to tell stories with classic beginnings (*e.g.* "once upon a time") but only in the STT condition did children also consistently finish their stories with classic endings (*e.g.* "the end"). Stories told with UTT tended to end in either false starts or long pauses indicating that children may have been having difficulty planning the next utterance.

6.3.3.3 *dialogue construction*

As in the earlier pilot studies, children consistently used STT body pieces to represent dialogue turns, assuming different voices and characters in each part. No child using UTT recorded dialogue turns.

6.3.4 **summary**

This study shows that TellTale's segmented interface seems to help children tell stories that are longer, more cohesive (containing fewer disfluencies and more conjunctions) and with more traditional beginnings and ends. Children also seem to use TellTale body pieces as “linguistic containers” to help them plan, organize and revise their stories. They consistently used TellTale body pieces to mark discourse segments, taking different narrative perspectives for different body pieces. The skills children practiced while playing with the segmented version of TellTale (planning, chunking, revising) are very similar to those that are required during written literacy exercises. These findings suggest that, with respect to segmentation, TellTale encourages children to tell oral stories in ways that are similar to how they will eventually construct written texts.

It is interesting to note that the stories children told with Unified TellTale strongly resemble those told by children with a language learning disability (LLD). Recall that Liles and Purcell (1987) found that children with an LLD were less able to repair inaccurate statements. Also recall that

MacLachlin and Chapman (1988) observed that the narrative retellings of children with LLD contained more communicative breakdowns (including disfluencies) and fewer causal connectives at episode boundaries. Silliman (1989) argues that children with LLD consistently fail to plan and integrate narrative elements, resulting in less coherent stories.

It is too early to speculate on how TellTale may be used by clinicians in diagnostic or therapeutic settings. However, it is interesting to note that by simply altering one feature of the TellTale interface, children's stories became dramatically worse along the same dimensions that are used to diagnose children's language learning disabilities. (An important caveat when considering this analysis is that it is not known whether any of the study's participants had an LLD.)

One criticism of this study (Susan Goldman, personal communication) is that, instead of investigating children's language abilities, it may in fact be showing that children have limited working memory to dedicate to a story-construction task. Indeed, children who used Unified TellTale could not divide audio into easily manageable "chunks." They were required to remember more information than the children who could record shorter story pieces using STT. Indeed, designers trying to support children's natural language play should be aware of the children's cognitive limits and the effect these limits may have on language tasks. It is unclear exactly how children's working memory is related to their ability to produce oral texts. A future

study may better separate these two phenomena.

6.4 the third study: evaluating collaborative authorship

TellTale attempts to encourage children to tell collaborative stories by creating, sharing and revising language together. One hypothesis resulting from the earlier pilot study was that children who played with TellTale together would use collaborative techniques to establish coherence within a story. It was thought that TellTale might help children mediate and negotiate aspects of the joint story-construction task. Perhaps children's play with TellTale would reveal strategies for establishing coherence previously not observed during children's collaborative storytelling.

This study (also presented in Ananny (2001)) was also seen as an opportunity to investigate how TellTale may support the language play of children from different socio-economic strata (SES). Specifically, this evaluation investigated whether children of high- versus low-SES establish cohesion within oral narratives using different strategies.

6.4.1 method and data analysis

In late November and early December 2000, a study was conducted in Dublin, Ireland to investigate this issue. A total of 22 children participated: 5 low-SES dyads (10 children) and 6 high-SES dyads (12 children). Of the 22 children, 8 were girls (4 girls in the low-SES condition; 4 girls

in the high-SES condition) and 14 were boys (6 boys in the low-SES condition; 8 boys in the high-SES condition).

The sessions with low-SES children were conducted at an inner-city Dublin school identified as “disadvantaged” by the Ministry of Education. The sessions with high-SES children were conducted at a suburban Dublin school identified as “advantaged” by the Irish Ministry of Education. To create the narratives, all children played with version 2 of TellTale, *i.e.* the same prototype used in the pilot study and the same prototype used by children in the segmented condition of the previous study.

All children were either 6 or 7 years old (ranging from 6,1 to 7,6) and were chosen randomly from classes at two separate schools. All children (except one native-English African girl in the low-SES children) were white, native-English speaking and Irish. In both dyads children were classmates and knew each other before the session.

In both high- and low-SES conditions, children were given 20 minutes to play with TellTale. As a story elicitor, children were given a sample narrative setting on which to base their story (TellTale was lost in the forest and met a new friend) and the children were left with several open-ended questions to help facilitate their storytelling. (*E.g.* what kind of forest creature did he meet? What’s the forest creature’s name? Where did he meet his friend?)

In both conditions, the experimenter was in the room, sitting at a separate table. In all sessions, the children's play was video-taped and audio-recorded. The experimenter later transcribed and analyzed the data for the following features: at least one story "event"; at least one conjunctive phrase (from the same set used for the previous study: {and, then, however, when, while, after, later, so, therefore, one day}) at the beginning of the utterance or at the end of the utterance; whether co-participants' utterances were co-occurring.

6.4.2 sample stories

The following are transcript segments from two sample two dyads, one with low-SES children and one with high-SES children. Within each sample, bold text represents the recordings of one participant and italicized text represents the recordings of the other participant. The time column indicates the approximate separate turns taken. Two pieces of text within the same row indicates co-occurring utterances and that, although children always had five TellTale body pieces available, they often used only a subset of these.

The following is a story told by two low-SES children. Note that the two children were often recording at once and that there are few word-based connectives used to establish coherence between story segments.

table 6-5: a sample story told by two low-SES children (6,6 & 6,7)

Time	Body Piece #1	Body Piece #2	Body Piece #3	Body Piece #4
1				<i>TellTale was a little pig and he was very good to people but he didn't have a choice. He didn't have a choice of what to do.</i>
2	TellTale was a great skunk. He lived in the forest with all the skunks. He seen one skunk eating a bat.			
3		He was a great skunk. He had a ... a ...	<i>TellTale was very good. He was going ... looking around the forest all day. But he had no arms.</i>	
4		TellTale was a big fish! (singing) lalala this is the end of TellTale!		<i>TellTale was the ... the ... this is the end of TellTale because TellTale was a very good manager. "TellTale, you succeed! But I'm the age that you are"</i>

The following is a story told by two high-SES children. Note the canonical turn-taking, the explicit conjunctive phrases and the incorporation of each other's story pieces across turns.

table 6-5: a sample story told by two high-SES children (7,1 & 7,2)

Time	Body Piece #1	Body Piece #2
1	This is a story about a caterpillar. There was once a story about TellTale and he lived in the forest. He had no friends. He was new. He only lived with his family. But then one night when he was out in the forest he set a trap and who did the trap catch? Not only the PlayStation star Spiro the dragon. And the dragon said ...	
2		<i>And Spiro the dragon said "get me out of this trap, I can't help it. Mom and Dad, help me!"</i>
3	And then TellTale says "okay, pipe down" and then Spiro comes down and he says ...	
4		<i>"Okay, I'll be grateful if you'd get me out of here but ..." (with rising intonation)</i>
5	"Okay, okay, I'll let you down." Snap goes the rope. Spiro comes down. Spiro says "thank you, my dear, do you want to be friends?" "Okay," said TellTale, "let's go." TellTale and Spiro ... (with rising intonation)	
6		<i>Went to the ocean for a swim but, then simply, as the time passed, something happened ...</i>
7	There was a shadow in the water ...	
8		<i>But it wasn't TellTale or Spiro.</i>

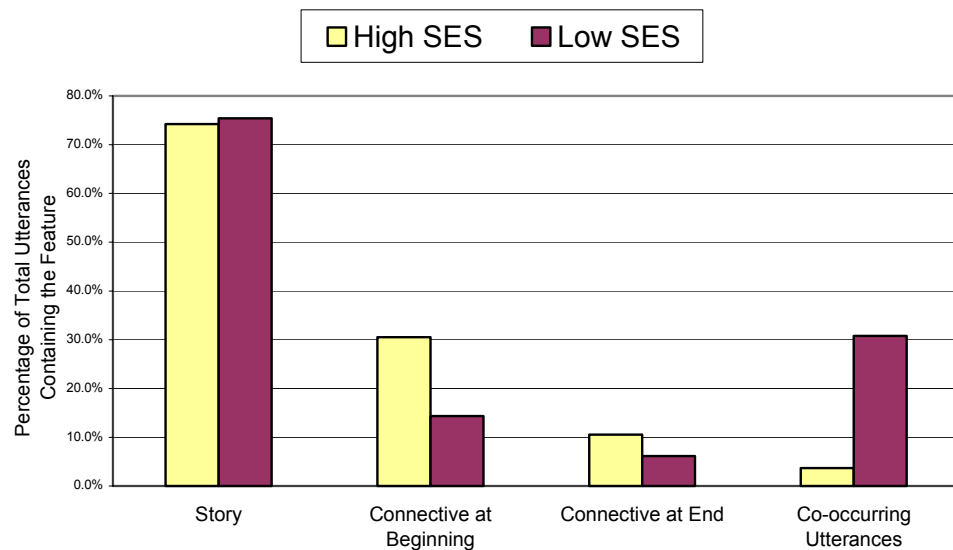
6.4.3 quantitative results

Children from both high- and low-SES groups consistently recorded utterances that contained story events (in both conditions,

approximately 75% of all children's recordings contained at least one event).

Children from both high- and low-SES groups also used connectives at TellTale body piece boundaries but children from high-SES consistently used more connectives. Furthermore, children from high-SES used more conjunctives at both the end and beginning of utterances: 31% of high-SES children's utterances contained conjunctive phrases at the beginning whereas 14% of low-SES children's utterances contained conjunctive phrases at the beginning; 11% of high-SES children's utterances contained conjunctive phrases at the end whereas 6% of low-SES children's utterances contained conjunctive phrases at the end.

figure 6-6:
high-SES
versus low-SES
utterance
features



Another feature along which children's recordings were analyzed was co-occurring utterances (*i.e.* when the two participants were

recording utterances simultaneously): 4% of high-SES children's utterances were co-occurring whereas 31% of low-SES children's utterances were co-occurring.

6.4.4 qualitative results

6.4.4.1 incorporations

Both high- and low-SES children incorporated both narrative (characters, places, actions) and syntactic (exact word phrases) aspects of their partner's utterance into their own. But preliminary qualitative observations seem to suggest that low-SES children tended to make incorporations simultaneously (*i.e.* during co-occurring recordings) whereas high-SES children tended to incorporate each other's content across consecutive recordings.

6.4.4.2 "non-narratives"

Despite explicit instructions to tell a story using TellTale, children from low-SES group often (for approximately 22% of their utterances) used TellTale body pieces to record song fragments both individually and in pairs.

6.4.4.3 turn-taking

Children from both high- and low-SES consistently seemed to engage in turn-taking through paralinguistic means (*e.g.* rising and falling intonation) and non-verbal means (*e.g.* gestures and eye-gaze). Preliminary

review of the data suggests that children from low-SES group tended to use either no turn-taking strategy or more non-syntactic turn-taking strategies (*e.g.* paralinguistic and non-verbal).

6.4.5 summary

Overall, children from different socio-economic strata tended to engage in slightly different behaviors during collaborative storytelling. Although both groups consistently recorded what are considered to be traditional, well-formed stories, the two groups seemed to be using different strategies to establish coherence between both their story elements and their social interactions. Specifically, an initial analysis may interpret low-SES children's high percentage of co-occurring utterances and low percentage of syntactic connectives as an indication that they are less able to engage in good turn-taking behaviour and that they are less aware of their co-participant.

However, the qualitative data suggest that this may not be the case for two reasons: children from the low-SES group appear to be using more subtle, non-syntactic, paralinguistic and non-verbal strategies to indicate turn-taking during story construction. Also, despite the high percentage of co-occurring utterances in low-SES children's recordings, these children consistently incorporated elements of their partner's utterances simultaneously. Children from high-SES tended to establish coherence using syntactic connectives between consecutive recordings. In short, syntactic measures of turn-taking

such as conjunctive phrases and consecutive recordings may not be good indicators of collaborative story construction. The consistent appearance of more conjunctive phrases at the beginning of recordings compared to at the end of recordings (in both high- and low-SES groups) suggests that children concentrate more on establishing coherence with previous utterances than planning for coherence with future utterances.

Future work will include analyzing in greater detail the type and frequency of both narrative and non-narrative incorporations as measures of children's strategies to establish coherence during collaborative story construction.

6.5 interviews with teachers

A series of structured interviews was also conducted with several elementary school teachers. These educators are currently teaching language skills to children in traditional classroom settings, one of the environments in which TellTale may be used.

It is important to note, though, that a traditional classroom environment is very different from the natural play context for which TellTale was originally designed. An overtly pedagogical environment in which children are actively being taught has a differently structured than a context in which children are designing their own learning through open-ended play.

The interviews were conducted in early December, 2000 at an inner-city Dublin school, the same school in which the third study took place. All interviews were audio-taped and later transcribed by the experimenter. Each teacher was interviewed individually and each session lasted approximately 40 minutes.

Four teachers were interviewed (all names have been changed): Erin has been teaching for approximately 20 years and leads a senior infants class (children aged 5-6 years old, equivalent to senior kindergarten in North America); Jennifer began teaching in the fall 2000 and leads first class (children aged 6-7 years, equivalent to first grade in North America); Emma has been teaching for 2 years and leads fourth class (children aged 9-10 years, equivalent to fourth grade in North America); Megan has been teaching for 4 years and leads third class (children aged 8-9 years, equivalent to third grade in North America).

The interviews were structured around two general questions. First, the teachers were asked to describe the classroom activities and tools they currently use to teach children language skills. Second, after a demonstration, they were asked how they might use a toy like TellTale in their classrooms. Summaries of their responses are presented below.

6.5.1 current classroom activities

All teachers said that they tried to incorporate language instruction into all aspects of the curriculum. The Irish Government's English Language Curriculum (Government of Ireland, 1999) applies to the entire country but all teachers agreed that there is considerable freedom to implement the curriculum's goals in a variety of ways.

They also all agreed that inner-city schools offer special challenges. Erin said that she often feels as if she's teaching English as a first language because children's home language environments are so impoverished. She said "language is our biggest problem because it's maths, it's music, it's everything, you know?" All teachers said that their children would likely have few books at home and would likely not be read to very often if at all. (This seems to agree with Adams (1990) estimation of low-SES children's home language activities, discussed in Chapter 3, "Literacy Theory.")

One problem Erin consistently encounters is getting children to answer her questions with more than a single word. Even when she explicitly asks students to use complete sentences she said that they seem to have difficulty constructing a coherent series of words. The other teachers agreed that, in general, teaching children how to sequence language is difficult.

(When considering these comments, it should be noted that most of the teachers had already seen TellTale. They had likely formed

opinions about what the interface may be useful for. Therefore, it is hoped that such comments regarding language sequencing are truly representative of teachers' current challenges and not intentionally made to be relevant to TellTale and teachers' impressions of the research goals.)

Emma and Megan (who teach fourth and third classes, respectively) said that they try to have children engage in writing activities as often as possible. However, Emma noted that many of the children are hesitant to “take risks” when writing for fear of misspelling a word or not printing neatly enough. To address this, Emma said she often uses “circle time” as a way to have children practice oral storytelling in a less formal context. She remarked that “it’s easier to take risks in oral language and it’s easier to take risks in play situations.” Erin confirmed this, saying that “particularly in a school like this, children are far more comfortable with speech.” Megan also agreed, saying that “the oral medium is much safer.”

Jennifer said that – to help introduce writing – she sometimes has children dictate stories for her to write down. She reported that this was problematic for two reasons. First, she did not have enough time to transcribe every child’s story. Second, she noticed that many children became nervous when they started to dictate. They seemed to become anxious about what they were saying and constantly asked for feedback.

But all teachers also said that children were usually eager to present their

stories in some tangible form, whether as pictures or in words. Megan said “it’s not enough to just tell [the story] – they really want to get in on paper or get it into some permanent form.”

All teachers also said that they frequently use different objects to facilitate storytelling. The teachers have children mediate turn-taking by passing objects. Emma (a teacher with experience in dramatic arts education) said that she frequently uses objects to represent different parts of stories. For example, she sometimes passes out different pieces of clothing and then has students tell a story about each item. She encourages children to link their stories using the objects as a way of focusing attention. Emma said that “if each person has an object it holds their attention, letting them focus their work on achieving something with that object ... It’s too abstract if you do just pure mind.” Megan agreed, saying that she finds it difficult to talk with children about abstract concepts such as a story beginning, middle or end.

6.5.2 proposed classroom uses of telltale

After discussing language instruction techniques, teachers were given a demonstration of TellTale. They were then asked to brainstorm about how they might integrate the toy into their current classroom activities and describe any new lessons a toy like TellTale might suggest.

All teachers agreed that TellTale would be most useful for teaching children how to sequence and organize language. Erin (the senior

infants teacher) said that she might have children record a single word into each body piece to demonstrate how complete sentences are constructed. She also thought she might use TellTale to help children record scripts or plays describing a certain action or event. Erin said that she commonly uses “themes” (*e.g.* water, seasons, colors, *etc.*) to help children structure stories and thought that TellTale might help them build up a large script from smaller descriptions or actions. “I’d like to see,” Erin said “if children might add bits onto the story in pieces and listen to what had come before.” Erin also stressed that TellTale might be a good tool to ensure that quieter children could contribute to language construction activities. She said that she would be sure to give shy students a body piece so their voices could be heard, too.

Jennifer – who earlier described how difficult the transcription process is – said that she might give TellTale to a child who was having particular trouble with writing. She thought that if the children could first record (and then later transcribe) their stories they may become less inhibited by the whole writing exercise. Jennifer also thought it would be easier to transcribe a story in pieces rather than have to write the entire story at once. “It might be less risky,” Jennifer said. Emma agreed and said that she would actively encourage children to make mistakes using TellTale.

Emma also said she might try letting certain children bring TellTale home. She has observed that some children find it difficult to concentrate on

writing exercises in the classroom but that they receive little or no language support at home. The result is that they rarely find a comfortable environment for composing and experimenting with language. A toy, she said, that let children make up stories independently and outside of school, might help some students realize that language creation can happen anywhere at any time. She also thought that since TellTale was a physical object, children might feel some attachment to it. “It would be their own thing,” she said.

One criticism all teachers had of TellTale was that it may be distracting to use in the classroom. Because it encourages children to be record and play sounds, the teachers thought that it would disrupt others’ activities and make quiet language study difficult.

During Megan’s interview, she herself told one story that illustrates how some children view the relationship between writing and speaking. One day, Megan said she asked all the students to write a story on any topic they liked. All the children, except one, decided on a topic and slowly began writing their stories. One student, though, adamantly refused to write and said that he “couldn’t print and didn’t know how to do stories.” After several unsuccessful attempts to convince him otherwise, Megan relented and let him draw while the others were writing. Later that day, the school’s principal came into the classroom to hear the children’s stories. When he asked the boy who had refused to write to read him his story, the boy slyly picked up a

blank piece of paper and proceeded to “read” what Megan described as a “perfectly coherent, interesting and entertaining story.” Although the boy had expressed little interest or ability in writing, he was capable of constructing an “oral text” that was both complex and engaging. It is hoped that TellTale may be a tool for such children to experiment with language expression.

6.6 conclusion

This chapter has demonstrated how children use TellTale to construct oral stories in a way that is similar to how they may eventually create written texts. The early pilot studies showed that children use TellTale to record oral stories in novel and engaging ways and that the TellTale prototype could withstand prolonged use. This pilot also helped establish protocols and hypotheses for later tests.

The next study showed that TellTale’s distributed interface helps children create stories that are longer, are more cohesive, contain fewer disfluencies and contain more conjunctive phrases. This study also showed that children use TellTale’s segmented structure to embody dialogue turns and narrative beginnings and endings. The final study showed that children’s use of TellTale can reveal important subtleties in children’s collaborative language play. Specifically, the study suggests that children of different socio-economic strata may use different linguistic and social strategies to establish

narrative coherence.

There is certainly more evaluation to be done to better understand children's use of TellTale and its relationship to the composition model. The goal of these initial tests was to show that (with respect to the thesis' original claim) a tangible, technology-enhanced oral storytelling toy could indeed let children practice certain language skills that are important for later written literacy. Future evaluations may better investigate this relationship but these initial results indicate promising applications of both TellTale and the composition model on which its design was based.

7: future work

7.1 introduction

The purpose of this chapter is to review future work related to some of the issues presented in this thesis. The chapter is organized into three sections: future empirical evaluations, future designs and future research directions. All sections are motivated by results of the design process described in Chapter 5 and the tests reviewed in Chapter 6.

7.2 future evaluations

The evaluations described in Chapter 6 were an initial attempt to determine what effect TellTale was having on children's oral language construction and how these behaviors were possibly related to written literacy skills. While these tests revealed some initial trends, there is more evaluation to be done.

First, it would be interesting to let educators use TellTale in classroom language exercises. In their interviews, teachers described several ways TellTale may be incorporated into the curriculum. For example, TellTale

may be used during a normal classroom story-writing task. As one teacher suggested, they could first record and edit a story using TellTale and then transcribe that story using traditional paper and pencil. A comparison could be made among the children's writings when they used TellTale as the basis for transcription, the children's writings when a teacher transcribed and children's writings when they had the help neither TellTale or a teacher. This might be a good way of determining exactly what role the toy might play in a written literacy task. The evaluations thus far have focused on supporting composition *processes* but no evaluation actually investigated how TellTale's use may affect the act of composing written text.

Although the research thus far has focused on children's use of TellTale during language production, it might be interesting to investigate how the toy might be used in language comprehension tasks. For example, each TellTale body piece could be pre-loaded with a story segment and then presented to children in pieces to see how and why they assembled the story segments. Such tests could be compared to work by Appleby (1978) and others on how children perceive and understand narrative structure. For younger children who may find constructing a whole story difficult, a single body piece could be left "empty" for them to construct a new ending or beginning.

Finally, it would be interesting to reanalyze the data collected during the third study (the experiment conducted in Dublin with children of high- and low-socio-economic strata) along a particular dimension. As mentioned in

Chapter 3, Hicks (1990) suggested that children of high-SES tend to tell stories that are more factual or list-like in nature whereas low-SES children tend to tell stories that use more psychological verbs or “verbs of feeling.” As far as is known, few other studies confirm this observation. It might be interesting to see if this same pattern is present in the data already collected for the third study.

7.3 future designs

During the design process, several modifications to TellTale were considered but never implemented.

Specifically, one idea was to create a set of “physical conjunctives” that could be placed between body pieces. When the signal flowed through one of these physical conjunctives, the word associated with that piece (*e.g.* “and”, “or”, “but”, “if”, *etc.*) would be played. Although these segments would introduce pre-scripted content into the play, they may encourage the construction of coherent language among children who are not yet comfortable with explicit connectives. By observing children’s use of these pieces, some patterns (perhaps age-specific) may emerge regarding children’s preference for certain conjunctives. Peterson and McCabe (1991) have classified children’s use of connectives in relation to age so perhaps future TellTale-like designs may incorporate age-appropriate language organization tools.

A similar idea is to have TellTale body pieces that contain no audio actually encourage children to continue their stories. For example, if a child were playing alone and just finished recording into the yellow body piece, a nearby blue body piece may say “tell me what happens next!” Again, this type of function may create a more scripted play pattern but it may also be a way for technology to scaffold children’s storytelling in a way that peers and adults normally do.

Another design idea was motivated by some comments made during user testing. Many children wanted to save the stories they created with TellTale, letting them use the toy to create new narratives while still retaining their previous work. One idea was to create a “butterfly” children could use to save their TellTale stories. Once their story was finished, they would be able to “export” it from the caterpillar to the butterfly, perhaps using an infra-red link.

Another possible future design relates to the inherent linearity assumed in all previous designs. As mentioned in the Chapter 5, “Design,” toys that allow different physical configurations of language segments may also support the TellTale Composition Model. For older children, it may be interesting to develop toys that allow different structures (*e.g.* branching for alternate endings). However, such designs should carefully consider two issues: how exactly creating create non-linear language structures relates to written literacy skills; and which natural metaphors that children are already familiar

with best support non-linear structures. The danger with introducing composition toys that allow complex structures is that they may actually become generalized data-management tools for representing abstract information and not representative of young children's natural behaviors. Such an approach would have to be firmly grounded in developmental literature that explains how children create associations between conceptual information *and* how language skills develop.

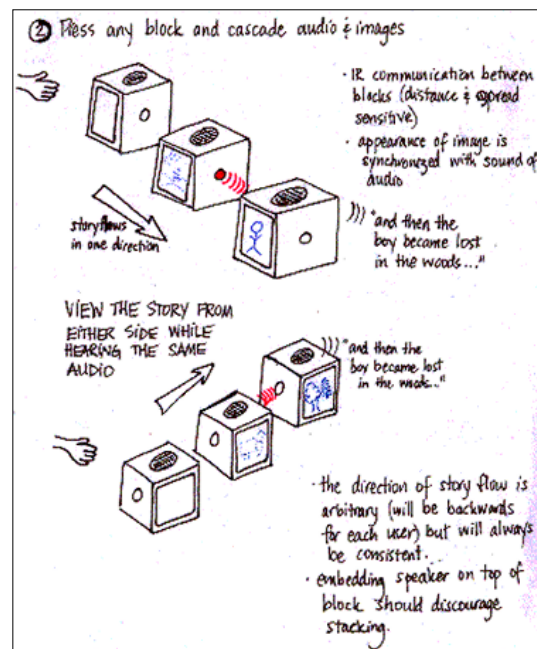
One other area to investigate further is how drawing may relate to early literacy activities and how children manage multiple media (images, audio) during story-construction tasks.

Collins (1999) writes that "literature on children's picture books suggest that there are connections between the function of illustrations in children's books and 'pictures in the head' which are evoked by told stories." It might be interesting to see whether a similar relationship exists when children compose their own stories. The Irish Government's English Language Curriculum (Government of Ireland, 1999) states that "children should not necessarily be 'weaned' from pictures; they may be a valuable form of expression." Teachers frequently said that children begin their story-construction tasks by drawing pictures. It is not clear exactly how children's use of KidPad (Benford, *et al.*, 2000) affects children's language skills, but it would be interesting to take a feature-based approach (similar to the one described in the evaluation chapter) to investigate how children's use of

drawing software actually relates to literacy acquisition. Pontecorvo and Orsolini (1996) suggest that “the initial phase of writing development begins with the differentiation of writing from drawing” and Barr (1988) argues that drawing is an intermediary stage in which children first start to understand the relationship between letter forms and letter meanings. Therefore, interfaces that support drawing during in story composition may be an appropriate way to help young children acquire writing skills.

To address this point, some early prototype sketches were prepared of a new interface, called *iTona*. The toy is a set of three six-sided blocks. Children

figure 7-1:
iTona is
designed to
let children
construct
physical
multimedia



can record audio into each block and draw a different pictures on each of the two opposing block faces. Each block would contain two color PalmPilot screens on which the children would draw. They could record audio or draw

pictures in any order and each block is not required to contain both audio and picture.

“Playing” a single block would cause the children’s pictures on both sides of the block to appear for the duration of the block’s audio. When two or more blocks are linked together to form a linear physical structure, “playing” the blocks would cause the audio-visual media associated with each block to be played in the same sequence as the blocks.

In essence, the goal of this new interface would be to develop an audio-visual storytelling toy that encourages the same type of language play suggested in the TellTale Composition Model.

7.4 future research directions

The research, designs and evaluations in this thesis were carefully constrained to address a very specific claim. Several issues were avoided either due to time or scope restrictions. But with this central claim adequately addressed, it is interesting to consider future research directions.

First, perhaps TellTale is really a new type of tool for letting children represent and manage language, regardless of whether it has any effect on literacy skills.

Giving very young children the power to create artifacts and produce

language is a new opportunity perhaps afforded only by digital media. As much as this thesis has argued that composition models should be “media-independent” with respect to oral and written language, perhaps future models should also be “media-independent” with respect to digital computation. *I.e.* perhaps the true power of computation is the ability to represent semantic information in whatever medium the user wishes. In effect, the medium doesn’t matter – it’s the ideas and the interactions that matter. If digital technologies are to offer new experiences, we should be focusing our efforts on supporting how people make external meaning, regardless of the medium. Perhaps children who grow up with this new form of “medium-independent” expression will be better able to understand media features and have superior mastery of whatever means are required to communicate.

One aspect of this new method of composing process particularly suited to digital technologies is collaboration. As children are able to represent and structure semantic content in external representations at a younger age, they must also be able to share and discuss these new works. As Papert (1980) argues, a critical aspect of learning is having a community in which to create and debate shared cultural artifacts. If we truly wish to engage young children in language and composition through “medium-independent” experiences, we must include support for collaborative learning.

These are vague ideas. But they represent the first attempt to describe a

broad research approach that simultaneously considers how children produce language and collaboratively learn and what the exact role of digital media are in that process. In short, if digital technologies are to make an impact on how children acquire language, they must offer profoundly new ways of creating and interacting with semantic content. Merely modeling traditional activities is not good enough.

7.5 conclusion

The design and evaluation ideas presented in this chapter describe some of the future directions this research may take. In future evaluations, it is important to continue focusing carefully on children's actual oral language use and how their behaviors may relate to future literacy skills. In future designs, it is important to continue making tools that leave control of the semantic creation and organization in the metaphorical – and physical – hands of the child.

8: conclusion

In thesis, a new model of composition and a new interface have been presented. Together, they are designed to investigate the claim that a tangible toy that supports oral language composition can help children acquire certain skills important for later written literacy.

Related research on the theory of “emergent literacy” was presented to support a model of composition that includes the following features: children creating language in their own voice; children structuring their own language; children making reference to linguistic units; children reflecting upon and revising their language; and children sharing and discussing their language with others.

One toy, called TellTale, was developed to support this composition model. The design process that guided TellTale’s development was also presented. It emphasized that a user-centered, iterative approach was most successful for creating a prototype that could be used to evaluate this thesis’ claim.

To test the claim, three studies were conducted. The first was a preliminary pilot study to evaluate the robustness of the prototype, the details of the experimental protocol and the validity of specific hypotheses related to children's construction of oral language.

The second study focused on evaluating the effect of TellTale's segmented interface structure on children's language play. The results indicate that TellTale's distributed components help children construct stories that are longer, are more cohesive (containing fewer disfluencies and more conjunctive phrases) and contain "better-formed" beginnings and ends. Children seemed to use TellTale body pieces as linguistic "containers" to structure and organize their stories.

The third study investigated how children collaboratively compose stories using TellTale, paying particular attention to possible differences between children of various socio-economic strata (SES). The findings indicate that children of both high- and low-SES use TellTale to construct stories and that children of both high- and low-SES tell narratives with more conjunctives at the beginnings of body pieces than at the end of body pieces. When data are separated according to SES, the results indicate that children from low-SES use fewer conjunctives than children from high-SES and that children from low-SES use TellTale to record audio at the same time, instead of carefully negotiating turns. But, children from both SES groups seemed to incorporate elements of their partner's story into theirs, although this

requires further investigation. The general conclusion from these results is that a purely syntax-based evaluation of how children establish coherence during joint storytelling may not be an accurate reflection of their collaborative authoring techniques.

Finally, this thesis concluded with several future research directions for the research. New evaluations and designs were presented that may better describe the relationship between oral and written composition and may result in more engaging and useful interfaces. A vague but promising description of “media-independent” composition was also presented.

This thesis has hopefully shown that children’s literacy skills develop along a complex continuum that involves composing both oral and written language. By developing new toys that support children’s natural language play, we may be able to show how technology can both support and enhance children’s pre-existing behaviors.

We may also come to better understand how children become proficient readers, writers and lovers of language.

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