MAIA: A Methodology for Assessing Imagination in Action

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ABSTRACT
We propose MAIA, a methodology to evaluate embodied storytelling systems aimed at supporting the child's creativity. Our approach rests on three key tenets: the study of process instead of objects, imagination as the basis of creativity, and creativity as recombination. MAIA uses micro-level analyses of enactment videos, the child's drawings and interview transcripts to generate a 'broader imagination' score that can be used for both quantitative and qualitative comparisons.

Author Keywords
Evaluation, Imagination, Children, Storytelling

ACM Classification Keywords
H.5.2. Information interfaces and presentation (HCI): Evaluation/methodology

INTRODUCTION
This paper proposes MAIA, a method to evaluate Creativity Support Environments (CSEs) through the study of the imagination at its point of occurrence. We address embodied systems that employ meaningful movements and gestures (or enactment) for interaction. We present our method in the context of technology-mediated children's storytelling. Many such storytelling systems involve the use of physical activity for interaction (e.g., Storymat [1], POGO [2], StoryToy [3] and StoryRoom [4]), and increasingly more so with the advent of innovatons like the *Wii* and *Kinect*. We first describe three key tenets that make up the philosophy behind our proposed approach and a brief review of previously used evaluation methods. We then explain our approach proper and present a case application, before concluding.

PHILOSOPHY OF MAIA

Tenet I: The Study of Process
"To encompass in research the process of a given thing's development in all its phases and changes…fundamentally means to discover its nature, its essence, for 'it is only in movement that a body shows what it is'" [5]. This quote from Lev Vygotsky illustrates the importance of studying processes instead of outcomes. We adopt this philosophy to look at creativity in the context of storytelling activities as it develops through the process of imagination.

We consider a CSE to be any system, artifact or object that seeks to facilitate the creative process that one engages in for a particular activity. A CSE can be evaluated in several ways – in terms of: a) How it supports the **person** to be more creative; b) How it enables the generation of creative **products**; c) How well it mediates the creative **process**; or d) Whether the technology furnishes a more effective **environment** for creativity.

A number of existing methods could be used for approaches a), b) and d). We found few methods adopting the approach c). Most that adopt **process** evaluation approaches employ a general mixed-methods framework. We found, however, that these lack specificity for children and do not provide exact guidance for our studies with embodied systems. Our approach seeks to evaluate the dynamic process (rather than the static products) of creative activity.

Tenet II: Imagination as the Basis of Creativity
Vygotsky places imagination at the genesis of the creative process stating: "the entire world of human culture … is the product of human imagination and of creation based on this imagination" [6]. Imagination, the ability to 'image' or 'see' distal or completely constructed worlds and possibilities, plays a key role: "every invention, whether large or small, before being implemented, embodied in reality, was held together by the imagination alone" [6]. Pelaprat & Cole [7] propose that imagination and creativity have a 'cyclical' relationship that is mediated by experience and knowledge. Experience shapes imagination, and imagination contributes to creative activity. If the output of creative activity is "perceived as new the products of imagination become creative when they enter the cultural world of interaction." [7]. Given its importance, we focus our approach on evaluating imagination, the root of creative activity.

Tenet III: Imagination and Creativity as Recombination
We observe that although they provide differing definitions, many researchers agree that creativity consists of a recombination of pieces from previously internalized experiences. Finke et al. [8] list the process of 'conceptual association and recombination' as the two important properties of creative cognition. Similarly, Boden [9] refers to 'combinatorial creativity', i.e. utilizing rules in a conceptual search space in new ways "to come up with new combinations. Fauconnier and Turner's [10] concept of 'conceptual blending' holds the same idea of combining domains. Vygotsky, in turn, calls creative activity, based on the ability of our brain to combine elements, imagination or fantasy [6]. Our ap-

proach embraces this idea of creativity as one engaging in a combinatorial process of 'idea bits'.

EVALUATING IMAGINATION

Imagination has been assessed in many different ways depending on the requirements of the study in question. The issue of a general assessment measure of imagination is complicated by the various ways in which the concept has been understood (e.g. it has previously been equated with memory, imagery, fantasy, invention or creativity). Some of the common measures that have been used include the numerous types of inkblot tests (Rybakoff, Whipple, Rorschach, etc.), textual measures (sentence building, story creation based around certain words, descriptions of imaginary animals, compositions, theme writing), studies of dreams and fantasy [11], or various scales depending on the definition adopted. Most of these measures are either not suitable for children, or do not measure imagination in-situ. From our first tenet, we are particularly interested in studying imagination in the process of its evocation. More importantly however, we could not find a method for analyzing imagination from gestures or enactment in the literature.

Loke et al. [12], Andrienko et al. [13] and the Laban Movement Analysis framework provide some indication as to how to analyze movement qualitatively but does not relate it to imagination in any way. Nemirovsky et al. [14] relate gestures to imagination using a method of analysis from psycholinguistics called microethnography, a "collection of techniques that focus on moment-to-moment bodily and situated activity". It is not always desirable, or even possible, to elicit co-produced speech from children enacting during the use of a system. We believe thus that a method of enactment analysis to elucidate the child's in-situ imagination is a substantial contribution.

MAIA: ASSESSING IMAGINATION IN ACTION

We devised a measure of imagination that we call 'broader imagination'. Broader imagination can be defined as including *any form of extension and association made beyond (visual, auditory, tangible, etc.) presented materials for the task at hand*. These extensions and associations can vary on richness, typicality with regard to a given situation and consistency over time. We use a multi-track approach to measure situated broader imagination from methods chosen to minimize the barrier of expression for children:

a. **Story enactments:** The child is given the task of telling a story with the CSE under study;
b. **Scene drawings:** After enacting, the child is asked to draw a scene that she enacted;
c. **Oral recall interviews:** At the end of the session, the child is engaged in a semi-structured interview about her enactments.

Data analysis in MAIA encompasses levels of micro-analysis of video and audio recordings, and collation of drawings. The video analysis serves to evaluate the richness of the enactment. We discern two types of analysis that moves from the objective level to the interpretive level:

1. **Generating Micro-Actions (MAs):** MAs represent the objective actions that the child performs in an enactment and consist of any action distinguishable as a unit.
2. **Generating Vignettes (Vigs):** Vigs represent the semantic interpretation of the set of micro-actions in the enactment: the mini-stories that the child is trying to tell. The interpretation of MAs into Vigs takes into account body postures, facial expressions, gaze, pace, etc.

We use analyses from the two other sources, interviews and drawings, to consolidate conclusions from the enactment analysis. Both serve as tests of richness and consistency of the imagination. The interview is used to probe about thoughts of the child during her enactment. Transcribed with timecodes, the interview is coded for four dimensions: the child's stated goal in the enactment (**goal**); the child's operationalization of the goal (**schema**); extra details that the child imagined (**extension**); and how consistent the child was during the interview in terms of intent, action and recall with regard to the enactment (**consistency**).

The drawings are coded for three dimensions: characters, if any, in terms of their suggested action (**character**); the scene or environment and any other elements in it (**scene**); and how consistent the child was in her drawing with regard to the enactment and the interview (**consistency**).

Finally, an 'overall broader imagination score' (OBIS) is given for each enactment, based on a gestalt view built from all of the child's enactment's micro-actions and vignettes, interview analysis and drawing observations. The OBIS, like scores derived from other parts of the method (number of MAs, Vigs, etc.) provides a representative number that can be used for quantitative comparisons. Procedures of MAIA can be summarized as follows. Intercoder agreement is sought after each step of analysis:

1. Code enactment videos for MAs, and collate a 'Repertoire of micro-actions'
2. Code the MAs for each enactment into story Vigs, and collate a 'Repertoire of vignettes'
3. While referencing enactment analysis, code interview transcripts
4. While referencing enactment and interview analyses, code drawings
5. Assign OBIS to each enactment from combined understanding of all analyses

CASE APPLICATION OF MAIA

As an instance of use, we describe a study where MAIA was applied. The study investigated the effects of using physical, tangible objects as support for the child's imagination in the context of enactive storytelling. Nine-year old children were asked to enact, using different types of objects (three versions of a toy frying pan, a toy pickaxe and a toy lantern), parts of a story that was shown to them digitally. After each act of the story, they were asked to draw a

scene that they enacted. At the end of the study, each child was interviewed for around 10 mins. Figure 1 shows a sample of data collected from the three sources.

The collected video stream was cut up to isolate each enactment of each child. Two coders analyzed each enactment video separately identifying MAs and their timings and recording these in a spreadsheet. Disagreements were then resolved in discussion and a consolidated 'action description' of the enactment was produced. For each enactment, the MAs coded in the consolidated action description were collated to produce the 'repertoire of micro-actions' for that particular enactment. Acronyms such as Flipping (F) or Put in Pan (PiP) were used to represent the MAs.

The two coders then generated the story Vigs by collapsing group of MAs, conferring upon disagreements. The 'repertoire of vignettes' was produced for each enactment. Acronyms were also used for the Vigs, such as Fanning Fire (FNV) and Misflip & Catch (MFCV). A sample of part of the consolidated coding sheet is shown in Figure 2.

After all interviews were transcribed and inserted into the spreadsheet along with the MAs repertoire and the Vigs repertoire, the two coders read and coded the transcripts separately and then together, for the four dimensions of goal, schema, extension and consistency. The two coders also coded the drawings for the three dimensions of character, scene and consistency.

Referencing the videos and the collated spreadsheet, each of the two coders gave an OBIS (by scoring on richness, typicality and consistency) to each enactment on a scale of 0 to 7. Unmatched scores (only 10%) between the two coders were resolved into a score that both agreed was adequately representative. Figure 3 shows the multi-track analysis of two enactments, one with a high and one with a low OBIS. The MA and Vigs descriptions of each enactment provide the coder with a mental model of the enactment while reading the interview and drawing analyses.

We highlight that neither one of the analyses (MAs, Vigs, drawing, interview) should be taken separately. Interpreting them as isolated analyses may at times lead to a very different OBIS than an OBIS from the holistic interpretation. We initially assigned OBIS based on the MA and Vig analyses only and conducted a separate coding session with six external coders who viewed simply the enactment videos. Conducting T-tests on the scores, we found that their given OBIS, as well as our initial ones, had very low correlations with our final OBIS generated based on the integrated view.

The OBIS were entered into SPSS for statistical ANOVA data analysis, together with personality and baseline performance scores as covariates. A significant main effect of object type ($p < .05$) was obtained, allowing us to evaluate how the various versions of the three objects differed in effectiveness in terms of imagination support.

CONCLUSION

We proposed a methodology that makes use of micro-analysis of various data sources to assess imagination as a process of creativity, focusing on embodied storytelling CSEs for children. We described how the approach was used to successfully analyze data from the study of a storytelling environment using physical objects. With further research, we believe MAIA can be adapted for use with other types of embodied creativity support systems for children that are not specific to storytelling.

Key
[]: Interviewer's interception
(): Ambiguous audio
**: Indecipherable audio
{}: Inferred action

CULTURAL PAN
[00:00:04.22] Interviewer: Tell me how you used this.
[00:00:09.04] P8M:
So it was like the mushrooms over here and I was standing over the fire and it was sizzling, like red and stuff.
[00:00:24.18] Interviewer: So the mushrooms were turning red. So what were you thinking
[00:00:35.23] P8M:
If erm the mushrooms were gonna be good

Figure 1. Sample of data sources: Left. Enactment video; Middle. Child's drawing; Right. Interview transcript

High-level Micro-Action Description	Micro-Action Repertoire	Vignettes
Child is in kneeling position throughout but with a more relaxed feeling than in Act 1. At the beginning of the enactment, he glances over at the female subject across the room using the cultural object. She was 'adding condiments' to her pan (PiP). He seems to follow her action. Throughout the enactment, he adds condiments, shakes the pan (small motion side to side) (HSS) and repeats the cycle. He generally looks at the pan and the cooking activity he is doing. At about 1:30 he seems to get bored and disengages. At 1.56, he seems to do a single flip (F) after glancing at the girl again (she was doing large flips).	1. Put in Pan (PiP); 2. Horizontal Shaking Side to side (HSS) 3. Flipping (F)	**Summary: BCV** (Basic Cooking Vig), **AIV** (Add Ingredients Vig) Child does BCV constantly with a lot of AIV. He does mostly SoF, adding a few subtle HSS at times and a single F toward the end. He adds ingredients throughout from both sides.

Figure 2. Sample of MA/Vig analysis spreadsheet

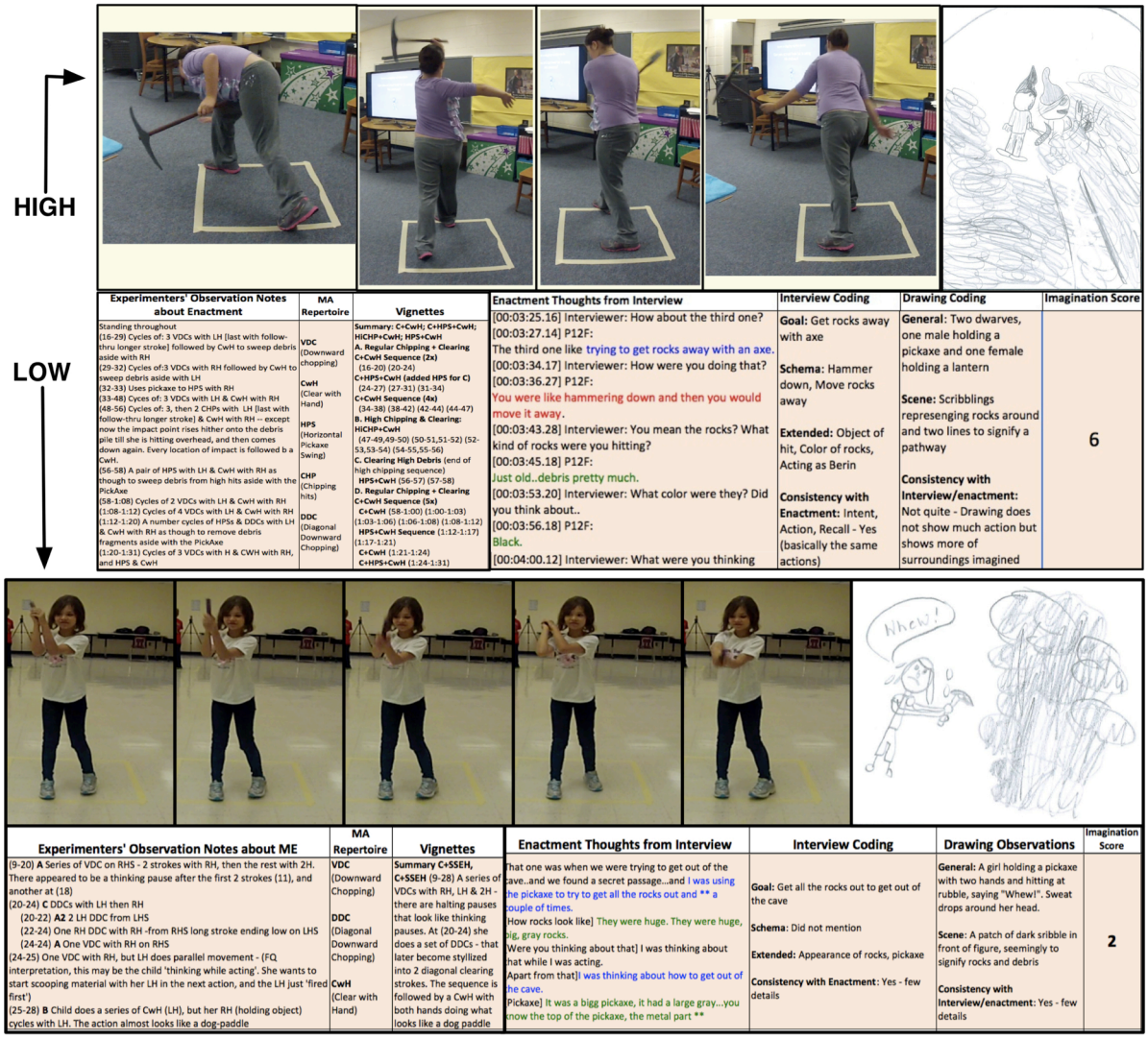

Figure 3. Sample analyses of enactments with a High and a Low OBIS. Top left part of each block shows frames from the enactment videos taken at intervals. Top right parts show the child's drawing of the enactment. Bottom parts show the MA, Vig, interview and drawing analyses, and the intercoder-assigned OBIS.

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