

# Gestures in the Storytelling Domain

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## ABSTRACT

A specific form of face-to-face communication is storytelling. Storytelling might also require a specific type of gesture usage. The research presented attempts to determine whether or not existing gesture generation systems can be applied to embodied conversational agents aimed at storytelling. The research involves the annotation and analysis of gesture usage in three storytelling videos. The results show that existing gesture generation systems could be applied in the storytelling domain. In addition to this the personal styles of storytellers are analysed and suggestions are made on how these might be implemented in the BEAT[CVB01] gesture generation system.

## 1. INTRODUCTION

Gestures are a part of face-to-face communication just like facial expressions, posture and obviously speech. The advantages of recreating humanlike communication between a human and a computer have been recognised for a long time. However, researchers have only recently attempted to “*design computer interfaces that can hold up their end of the conversation, interfaces that have bodies and know how to use them for conversation, interfaces that realize conversational behaviours as a function of the demands of dialogue but also as a function of emotion, personality, and social convention.*” [Cas01-p2]. These so-called embodied conversational agents come in many forms and with many different specific functions, one of which is a virtual storyteller. A good example of a virtual storyteller system, including a virtual talking head on the front-end, is the Virtual Storyteller project [TVS08]. Gestures, however, have not yet been implemented in this system because the virtual storyteller does not yet have a body. As the virtual storyteller, or a similar system, might evolve into an embodied agent it is relevant to research gesture usage in the storytelling domain.

In this research we would like to determine whether or not different rules apply to gesture usage in the storytelling domain compared to gesture usage in other domains of conversation. If so, we will try to determine where the differences lie and what is causing them. This should result in a concept of how appropriate gesture usage could be implemented in a virtual storyteller.

To determine whether or not different rules do apply we will annotate gesture usage in a number of storytelling videos, the results of which are then compared to previous research on gesture usage in other domains, as described in the literature. From this we can derive a list of differences in gesture usage. By taking a look at an existing gesture generation system we will determine how these differences in gesture usage can be implemented into this existing system.

## 2. RELATED WORK

We will start by defining the (different types of) gestures that will be used in our research. In section 2.2 we will discuss previous experiments and their results. These experiments involve researchers annotating the gesture usage of test subjects

while they explain something (in these particular cases the inside of a house or a cartoon) to another test subject.

### 2.1 Gestures

In [McN92] gestures are divided in Iconic gestures, Metaphoric gestures, Deictic gestures and Beat gestures. As this book is widely recognized as being authoritative in the gesture research field we will also divide the gestures in our research into these four categories.

A gesture usually refers to something; this can be an object, an action or something more abstract. What the gesture refers to and how it does this (by pointing at it or symbolizing certain features of it, like its size or shape) determines the category to which a gesture belongs.

We will briefly explain the different categories of gestures:

- Iconic gestures depict a characteristic of the actual object, person, action or event being described. Examples include an upward movement of the hand accompanied by the words “he climbed up the tree”. Another example would be a throwing motion, when someone in the scene throws a ball.
- Metaphoric gestures describe abstract concepts and relations. As the term implies the gesture depicts the metaphor of the concept or relation. Examples would include depicting a group by moving both hands in a ball shape, or progress by moving the hands around each other in a circular fashion.
- Deictic gestures are pointing gestures. They might point to real objects or persons, but quite often they point to entities in the imaginary world of the scene that is being described.
- Beat gestures are generally small, short movements which are used to emphasize certain parts of speech, or sometimes just as a filler, where no other gestures can be used. An example could also be the gestures people make when they can’t think of a word. Beat gestures are a bit of an exception in that they don’t refer to anything like the other types of gestures do.

For further details on the different types of gestures used in this research we refer the reader to [McN92].

As gesture generation and synthesis have become an important part of embodied conversational agents a lot of effort has been put into research on how gestures are built up and how they can be synthesized to be used by embodied conversational agents. An in-depth analysis of gestures used in a TV show and a proposed theory to structure different gestures is presented in [Kip01].

### 2.2 Related Experiments and their Results

We want to research whether or not the usage of gestures in storytelling differs significantly from the usage of gestures in other types of monologues. In order to compare these two types of conversation we will need to gather the required data. For regular monologue this will be done by a literature research, as a number of experiments have already been conducted on this subject.

In [McN92] an experiment is described which originally appeared in [ML82], this experiment involved one test subject watching a cartoon and then describing the cartoon to a second

test subject. While the story was being described the researchers observed what gestures were used by the first test subject. The results of this research are shown in table 1.

**Table 1. Results from cartoon experiment described in [McN92] expressed in frequencies and percentages**

	Type of Gesture				Total
	Iconic	Beat	Metaphoric	Deictic	
<b>Freq.</b>	261	268	43	28	<b>600</b>
<b>Perc.</b>	43.5	44.7	7.2	4.7	<b>100</b>

A somewhat similar experiment was described in [Yan00]. It involved a test subject being shown a video and floor plan of a house, the test subject was then asked to describe the interior of the house to a second test subject. The researchers annotated the gestures the person used while describing the different rooms in the house. The results of this experiment are shown in table 2.

**Table 2. Results from experiment in [Yan00] expressed in frequencies and percentages**

	Type of Gesture			Total
	Iconic	Metaphoric	Deictic	
<b>Freq.</b>	127	8	7	<b>142</b>
<b>Perc.</b>	89.4	5.6	4.9	<b>100</b>

Unfortunately Yan did not annotate beat gestures, instead he just looked at referential (iconic, metaphoric and deictic) gestures. In order to properly compare the results from the two aforementioned experiments we will therefore disregard the beat gestures from the experiment described in [McN92]. The results of this are shown in table 3.

**Table 3. Comparison of results from [McN92] and [Yan00] disregarding beat gestures**

	Percentages of Gestures from literature			
	Iconic	Metaphoric	Deictic	Total
<b>McNeill</b>	78.6	13.0	8.4	<b>100</b>
<b>Yan</b>	89.4	5.6	4.9	<b>100</b>

From this comparison we can derive that the domain of the experiments and conversations appears to influence the types of gestures quite a bit. This could mean that a gesture generation system specific to storytelling would increase the believability of the virtual storyteller because different rules for the generation of gestures would apply. However, the possibility that the same generation rules can be applied, because they lead to different gestures due to the different domain and content, also exists. We will come back to the cause of these differences in gesture usage between domains in the following sections.

### 3. EXPERIMENT

In our experiment we want to find out whether or not gestures are used differently in the storytelling domain, compared to the results of previous research as described in section 2.2. If they are in fact used differently we want to know where these differences lie.

#### 3.1 Approach

We will examine videos of storytellers and annotate the gestures they use. The gestures will be divided in the four categories

mentioned in section 2.1. The annotation will be done with the help of a software tool called ELAN [ELA08]. We can then calculate a frequency and percentage for each type of gesture. What we end up with is data which can be compared to that of the experiments discussed in section 2.2.

For our experiment it is important that the storyteller is standing up, which is not a given, as a lot of storytellers tend to sit down while telling the story. People tend to use gestures more expressively when they stand, however this should not affect the type of gestures they use, just the form. In addition to this, videos of storytellers that are sitting down are often framed to only include their head and part of their chest. Therefore the arms and hands are not constantly in view. Obviously this would render a video useless for our research. Unfortunately both experiments described in section 2.2 involved the subject sitting down. Even though there was no evidence found that this results in different types of gestures being used, there was also no evidence found to prove the opposite being true.

Due to time constraints we were unable to film storytellers ourselves. Therefore the videos used in this research were found on the internet, more specifically on YouTube [You08a], [You08b] and [You08c]. Screenshots of the videos are shown in figures 1 through 3. The videos used in this experiment had to be long enough to give us a good picture of the average gesture usage and at the same time not too long in order to keep the time required for annotation within reasonable limits. Therefore the length of all the videos used in this experiment was between 5 and 10 minutes.



**Figure 1. Storyteller Clare.**



**Figure 2. Storyteller Rab**



**Figure 3. Storyteller Yuri**

Clare and Rab are both Irish and are telling a typical Irish story, where Yuri is from Australia and tells an old Australian story.

The annotation of gestures will always be a relatively subjective task; unfortunately only one person annotated the gestures in this research. The fact that only one person judges the gestures further enhances the subjectivity of this research. Therefore we will now discuss a number of choices and decisions that were made with regard to the annotation process.

Sometimes the storytellers used a combination of a deictic and an iconic gesture. In these cases the annotator attempted to split up the gesture in a deictic part and an iconic part. If this was not possible the gesture was classified as deictic as that seemed to be the most clear and evident part.

Some storytellers used their own hands or whole body to represent that of a character in the story. For instance when the character grabbed their own head or arm the storyteller would do the same. As the storyteller references to a characteristic of the action performed by the character these gestures have been classified as iconic gestures. However, gestures like grabbing their chest (or heart) can also be a metaphor for an emotion a character is feeling, in which case it would be classified as a metaphoric gesture.

In [McN92] beat gestures are defined as follows: “Formless hands that convey no information but move in rhythmic relationship to speech”. In addition to this definition [McN92] also presents a beat filter, consisting of strict rules on the

physical properties to determine whether or not it was a beat gesture. In the annotation task of our research the definition mentioned above was used to annotate beat gestures, and not the beat filter. Even though the beat gestures were later disregarded for a large part of our research, the definition we used might have caused some gestures to be wrongly classified as a beat gesture. This might have influenced our results in some way, which is why this is considered a shortcoming of our research.

It should be noted that the annotation task in our experiment is considerably less reliable than those discussed in section 2.2, as in those experiments there were multiple researchers which results in the annotation being less subjective and less prone to errors. In addition to this the researchers in those experiments had the content which was being described (the cartoon, the floor plan and the video of the house) where in our experiment we only have the video of the storyteller.

### 3.2 Results

The results of the annotation of all three videos are shown in table 4. Here the gesture usage of each storyteller is expressed in percentages.

**Table 4. Results from annotation of storytelling videos, expressed in usage of each type in gesture in percentages**

	Type of gesture			
	Iconic	Metaphoric	Deictic	Beat
<b>Clare</b>	37	2.2	10.9	50.0
<b>Rab</b>	24.8	1.8	7.2	66.2
<b>Yuri</b>	18.6	4.7	29.1	47.7

We can clearly see that there seems to be some variance within the storytelling domain, with two notable differences being Rab’s high usage of beat gestures and Yuri’s preference for deictic gestures. Yuri uses many more deictic and many fewer iconic gestures. This is something that can be noticed when watching the video even without looking at the annotation data.

In addition to these results we also looked at the number of gestures used per minute, shown in table 5. With this we try to examine if there is a variance in activity with regard to gesture usage. As the videos were not transcribed we cannot correct these figures by taking into account the amount of words used per minute by each storyteller. However it does show that Rab seemed to use gestures at a much higher frequency, while he did not speak notably faster.

**Table 5. Additional results from annotation of storytelling videos, indicating activity of each storyteller with regard to gesture usage**

	Total gestures	Length	Frequency (Gest/min)
<b>Clare</b>	92	6:57	13.2
<b>Rab</b>	222	9:54	22.4
<b>Yuri</b>	86	6:43	12.8

When beats are disregarded the frequencies are a lot more similar, with Rab still being the most active with 7.6 gestures per minute, but Clare and Yuri not far behind with 6.6 and 6.7 gestures per minute. This confirms the notion that the high frequency of gestures used by Rab was due to the high number of beat gestures he made.

In order to compare our results with those presented in section 2.2 we have to disregard the beat gestures, as shown in table 6.

**Table 6. Comparison of results from annotation of storytelling videos with previous research**

	Percentages of Gestures from literature			
	Iconic	Metaphoric	Deictic	Total
McNeill	78.6	13.0	8.4	100
Yan	89.4	5.6	4.9	100
Clare	73.9	4.3	21.7	100
Rab	73.3	5.3	21.3	100
Yuri	35.6	8.9	55.6	100

We can see from this comparison that the storytellers seem to use a lot more deictic gestures. The relation between the percentage of iconic and metaphoric gestures seems quite similar to those in the other experiments. The percentages of iconic and metaphoric are a bit lower, but this is obviously due to the increase in deictic gestures. This increase in deictic gestures could be the result of two things, either the storytellers use different gestures to express similar content or the storytelling domain leads to different content which in turn causes the storyteller to use different gestures. A possible example of different content causing different gestures is the fact that storytelling involves quite a lot of descriptions of scenes, environments and characters, which results in an increase in the use of deictic gestures. In order to find out which of these two options is the case we take a look at existing gesture generation systems.

## 4. GESTURE GENERATION SYSTEMS

In order to determine what is causing the difference in gesture usage we take a look at how gesture generation systems decide which gestures to use.

### 4.1 An Existing Gesture Generation System

A number of gesture generation systems exist; BEAT [CVB01], AC [Cas94], and the gesture generation system implemented in MAX [KW02] are just a few examples. An overview of approaches to gesture generation and different gesture generation systems is presented in [Kip04]. We have decided to focus on the BEAT system as presented in [CVB01]. The BEAT system uses so-called generation rules to generate gestures. These generation rules are described in [Cas94] and [Cas01]. We will now discuss these generation rules in order to determine whether or not the storytellers in our experiment also abide by these rules.

*“Gestures that represent something (iconics and metaphoric) are generated for rhematic verbal elements (roughly, information not yet spoken about) and for hearer new references, provided that the semantic content is of an appropriate class to receive such a gesture: words with literally spatial (or concrete) content get iconics (e.g. “check”); those with metaphorically spatial (or abstract) content get metaphoric (e.g. “account”); words with physically spatializable content get deictics (e.g. “this bank”).” [Cas94-p4]*

In short this means that the gesture type to be used is determined by what information (special characteristics) is known about the subject (semantic content) and what the other person already knows.

It should be noted that the rules mentioned above are for the generation of gestures not for the definition of gestures. This means that not every aspect of the rules might apply to the way humans use gestures.

The following generation rules were mentioned in [Cas01]:

- *Beat gestures: occur primarily during the introduction of new material (rheme), they have low priority so they are usually replaced by other, more appropriate, gestures.*

- *Surprising feature iconic gestures: when an object is described that has an unusual feature (which is not mentioned in the speech) an iconic gesture is generated which shows this unusual feature.*

- *Action iconic gestures: are generated if the knowledge base contains an iconic gesture for the action being described.*

- *Contrast gesture: when the tagger recognizes contrasting objects that are close to each other (for instance “good or bad”) the contrast gesture is generated. This gesture involves ‘having’ one object in the one hand and the other in the other hand, like when people say “on the one hand... on the other hand”. When more than two contrasting objects are defined the contrast gesture is replaced by beat gestures.*

These generation rules will be used to determine whether or not the storytellers in our experiment abide by similar rules when using gestures. From this we can then derive whether the difference in gesture usage between the storytelling domain and other domains is the result of different generation rules or different content.

### 4.2 The Storytelling Domain

The videos were reviewed once again but this time we reviewed whether or not the storytellers abided by the aforementioned generation rules when it came to their use of gestures. As expected the storytellers did use the gestures properly, in the sense that they abided by the generation rules described in section 4.1.

An example of this is shown in figure 4 where Clare moves her arm in an upward motion while she utters the phrase “You had to be able to leap your own body height ...”



**Figure 4. Clare using an iconic gesture while uttering the words: “You had to be able to leap your own body height...”**

The upward motion reflects a characteristic of the leaping action that is being referred to.

Another example is Yuri using a deictic gesture while uttering the phrase “Some said he came from Bunker's Run ...”, this is shown in Figure 5. The deictic gesture refers to the location (or physically spatializable content) of “Bunker’s Run”.



**Figure 5. Yuri using a deictic gesture while uttering the words: “Some said he came from Bunker's Run ...”**

The variance in the results discussed in section 3 is therefore not accounted for by a different set of generation rules for each domain. It is much more likely to be caused by other factors such as the fact that a different domain causes a different so-called ‘input’ or content. A storyteller might quote characters more often, and describe different things. For instance a storyteller is much more likely to describe a scene, with several characters and their locations. This could explain the increase in deictic gestures and the decrease in metaphoric gestures compared to other domains.

This leads us to conclude that the current gesture generation systems such as the one described in [Cas01] could be suitable to use in the storytelling domain.

### 4.3 Variations within the Storytelling Domain

However, even in the same domain a lot of variance has been shown with regard to the types of gestures that are most used, as is shown in table 4. This leads us to assume that these differences have little to do with the domain and much more with the personal style and preference of a storyteller. As a lot of objects, characters or other things can be referenced by using iconic, deictic or even metaphoric gestures it is up to the storyteller which type of gesture they use. Some examples of difference in style are Rab using more beat gestures and Yuri using more deictic gestures.

As these personal styles seem to be part of storytellers it would increase the believability of virtual storytellers if these personal styles could be implemented. In order to enable virtual storytelling systems to have a personal style, while still abiding the generation rules, we are interested in what makes up these styles. In other words where exactly the differences in style lie.

## 5. PERSONAL STYLES

Implementing different styles in virtual storytellers would be a good addition to the system as people will likely prefer one style over the other when it comes to storytellers. However the response of people to different styles of the gesture usage by the

storyteller is something more research should be conducted on. We will now take a look at how these personal styles might be implemented in a virtual storyteller.

### 5.1 Adaptations to existing systems

In section 4.1 we have discussed the BEAT system, we will now take a look at how personal styles could be implemented in BEAT.

In order to determine which gesture to use, a gesture generation system uses generation rules as described in section 4.1. As we argued in section 4.3 the difference in style is mostly evident when the storyteller has multiple options for gestures. For instance Yuri seems to choose deictic gestures when he has the option to do so. So when multiple gestures would be appropriate we would like to let the decision be based on the personal style of the storyteller. The BEAT system implements the gesture selection module by using a system of priority. Every gesture is given a priority; beat gestures for instance are given a lower priority than iconic gestures. A filter then decides which behaviour should be selected, based on its priority.

This means the best way to implement personal styles of storytellers in the BEAT system is to define a new filter to be used in the gesture selection module.

When multiple gestures are available this filter would select the gesture most appropriate for the specific style of a storyteller. If the specified style does not prefer any of the multiple gestures suggested the filter could fall back on the priority filter already implemented.

More research would be required to determine exactly when different storytellers make different decisions. An example of this is Yuri choosing a deictic gesture when he might also have the option of an iconic gesture. However a personal style is defined by a many more such preferences. Due to time constraints and certain limitations on the videos used in our research, for instance the fact that all storytellers tell different stories, we are unable to fully define the personal styles of the storytellers in this fashion.

### 5.2 Elements of a possible filter

We will now take a look at what features might be included in a gesture selection filter based on a more in-depth analysis of the style differences between the storytellers in our videos.

As mentioned before the storytellers seem to abide by the guidelines for gesture usage, meaning the gestures they use are appropriate for the things they refer to. The difference then lies in their choices for a certain gesture when multiple gestures would be appropriate. We would like to determine what choices a storyteller with a certain style would make. Unfortunately our storytellers tell different stories, which makes it a little hard to compare their styles. We will therefore analyze how the storytellers handle a few concepts which are characteristic to a story and part of all three stories. The concepts were selected on the fact that the three storytellers use somewhat different gestures in these situations.

#### 5.2.1 *Something happens in the distance*

Clare uses a combination of a deictic and an iconic gesture, she moves her arm in a certain direction (the deictic part) but then she uses her hand and fingers to make a gesture indicating the object, action or character. For instance she would point towards a mountain, and use her hand to illustrate the movement of a deer on the mountain, which is a deictic gesture followed by an iconic gesture. This particular situation is shown in figure 6.



**Figure 6. Clare using a combination of a deictic and an iconic gesture to describe an event happening in the distance**

**Yuri** uses a deictic gesture, he just points his arm in a certain direction, sometimes uses his fingers to point, but does not really use an iconic gesture, and his style seems somewhat lazy in this way. An example of this is shown in figure 7. Although it should be noted that he sometimes does use a more clear pointing gesture as can be seen in figure 5.



**Figure 7. Yuri using a deictic gesture**

**Rab** uses a different gesture to Clare and Yuri. Even though he makes a deictic gesture, which is the same as Yuri does, he seems a bit less lazy and careless about it when compared to Yuri. An example of Rab using such a deictic gesture is shown in figure 8.



**Figure 8. Rab referring to something that's happening in the distance by using a deictic gesture**

### 5.2.2 Reference to a (new) character

It is mostly first references to a character that are accompanied by a meaningful gesture which tells something about the character, a characteristic or location for instance.

**Clare** tends to use her hands and/or body to depict some characteristic of the character, especially if it's a new character. She does this by using her body to represent the body of the new character. An example of this would be using her hands to show the character has long flowing hair or assuming the same posture as the character, e.g. the proud stance of a soldier or an older person bent over. In figure 9 Clare is shown in a proud stance.



**Figure 9. Clare using her own body to represent the proud stance of the character she is describing**

**Yuri** often doesn't use a gesture at all, but when he does he mostly uses a deictic gesture to refer to a character. When using this deictic gesture he usually just points his arm in a certain direction when uttering a person's name. This is basically the same gesture as shown in figure 7. This preference of Yuri for deictic gestures as opposed to iconic gestures is something also evident in other situations throughout the story where the other storytellers would likely use an iconic gesture.

**Rab** uses the same kind of gestures as Clare when referring to a character, in that he also tries to depict the specific characteristics of the character, just less frequently. He seems to use a lot less iconic and deictic gestures and more beat gestures, which do not reflect any characteristics about the character, as they don't depict anything. This also holds for situations other than just the reference to a character, as is backed up by the data discussed in chapter 3.

By further researching different storytellers in this fashion, different personal styles of storytellers could be defined and implemented in a gesture generation system.

## 6. DISCUSSION

It should be noted that even though the generation rules used by gesture generation systems were not designed specifically with storytelling in mind, they were constructed after observing real people. It therefore seems somewhat obvious that people will abide by these generation rules. However as we have done specific research into gesture usage in the storytelling domain, it cannot be assumed that the same generation rules apply, which validates this specific part of our research.

As we used the BEAT gesture generation system to analyze the cause of the difference in gesture usage between the different domains in section 4, we chose to take a look at how personal styles could be implemented in the same system. However, other systems which implement personal styles of embodied conversational agents exist. A good example is the GESTYLE mark-up language and accompanying system presented in [NR05], which includes the possibility for specification of gestures, underlying meanings, personality and even culture. Such a system would be a good base to implement the personal styles derived from a more in-depth research with regard to storytellers.

## 7. CONCLUSIONS

Our research indicates that storytellers do not use different gestures with regard to the type of gestures used to describe certain content. The difference in gesture usage between our experiment and those found in the literature seems to be the result of different content and personal styles of the storytellers.

This has led us to conclude that, according to our research, existing gesture generation systems such as the beat system would not be inappropriate to use in combination with a virtual storyteller.

Our experiment has also shown that there seems to be quite a lot of difference in the gesture usage of the different storytellers. We have assumed this is partly due to the personal styles and preferences of each storyteller. Although it should be noted that the fact that the storytellers were each telling different stories might also have caused some of the differences in gesture usage.

These different styles would most likely be an asset in creating greater believability for virtual storytellers and we have shown that it would indeed be quite possible to implement these personal styles in a gesture generation system such as BEAT. However it should be noted that BEAT is not the only system, nor necessarily the most suitable system, to implement personal styles in virtual storytellers or embodied conversational agents in general. We have also discussed a number of different elements which might be part of a personal style. However, more research is needed to define these personal styles more clearly and to find out how people respond to different styles of storytellers.

## 8. FUTURE WORK

More research should be conducted on the response of people to different styles of storytellers with respect to gesture usage. This could be done either by analyzing people's response to different real-life storytellers telling the exact same story. However as this would require the storytellers to use the exact same words, the storytelling would not be spontaneous, resulting in different gesture usage than usual. A better solution would be to implement a number of different styles in an embodied conversational agent and have this embodied conversational agent tell the same story several times while using different gesture usage styles.

Finally, as a side note, we would like to mention that in a research with limited samples, like this one, it's hard to notice any patterns or classes. However it might be interesting to see if the different styles of storytellers are somehow related to their characteristics such as sex or nationality. In our research nationality might be seen as an influence as the styles of Clare and Rab seem to be more similar than that of Yuri. However a research with a larger sample of storytellers and identical stories would be required to draw such a bold conclusion.

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