# Memory functions of co-speech gestures for child and adult speakers in spatial descriptions

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Signed Şule Öztürk

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## ABSTRACT

Do gestures play a role in keeping spatial information in memory during speaking? The present thesis aims to find out whether gestures those speakers spontaneously use while speaking plays a role in memory maintenance for children and whether and how this changes when compared to adults. 28 adults and 25 five-year-old child participants were asked to watch simple motion events shown to them on a laptop. They were then asked to retell what they had seen to an adult listener in 3 conditions; when the still pictures of the objects they were describing (1) were not visible on the screen anymore (2) were visible only to them but not the listener and (3) were visible to both themselves and to the listener. If children use gestures to keep spatial images in memory more than adults I expected them to use more iconic gestures per word when the objects they are describing are not visible (conditions 2 and 3) than when they are visible (condition 1). However my results did not support this hypothesis. I did find neither speech nor the iconic gestures per word to be different across conditions in both adults and children. Thus the memory maintenance function of gesture might not be a primary function of gesture. Instead our findings indicated other functions of gestures similar and different between adults and children in spatial descriptions. Both groups used more points to entities when they were available to both the speaker and the addressee than other situations, indicating children understood communicative situation as adults did. Finally adults used more gestures than children indicating that gestures may be used to organize complex spatial information during speech.


**Keywords**: Functions of gestures, memory maintenance, spatial information, iconic gestures, deictic gestures, children, adults

## ÖZET

Mimikler, konuşma sırasında mekansal bilgiyi hafızada tutmaya yardımcı oluyor mu? Bu tez, konuşma sırasında kullanılan mimik hareketlerinin, hafızada bilgi tutmaya yardımcı olup olmadığını çocuklarda ve yetişkinlerde karşılaştırmalı olarak araştırmayı hedeflemiştir. 28 yetişkin ve 25 çocuk katılımcıdan bir bilgisayar yardımıyla çeşitli hareketler seyretmeleri istenmiştir. Daha sonra gördüklerini yetişkin bir dinleyiciye, 3 farklı durumda anlatmaları istenmiştir. İlk durumda, izledikleri filmden hatırlatıcı herhangi bir resim önlerinde yoktu. İkinci durumda izledikleri filmden bir resmi sadece kendileri görebiliyordu. Üçüncü durumda ise, bu resmi hem kendileri hem de dinleyici görebiliyordu. Eğer çocuklar, mekansal bilgiyi hafızada tutmak için mimikleri yetişkinlerden daha fazla kullansalar, resmi gördükleri durumlarda görmedikleri duruma göre daha fazla mimik kullanırlar. Ancak bu çalışmanın sonuçları bu hipotezi desteklememiştir. Konuşma içeriği ya da mimik hareketleri hem çocuklarda hem yetişkinlerde durumlar arasında farklılık göstermemiştir. Hafızada bilgi tutma mimik hareketlerinin başlıca görevi olmayabilir. Bu çalışmanın bulguları göstermiştir ki, mimik hareketlerinin çocuklar ve yetişkinler için birbirine benzer ya da birbirinden farklı daha başka görevleri de bulunabilir. Her iki grup da resim dinleyici tarafından görülebilen durumlarda daha fazla işaret mimiği kullanmıştır. Bu da çocukların, yetişkinlerin bakış açısını anlayabildiğini gösterir. Son olarak, yetişkinler, çocuklardan daha fazla mimik hareketi kullanmıştır. Bu durum da, mimiklerin karmaşık mekansal bilgiyi organize etmek için kullanabileceğine dair bir bulgu olabilir.


**Anahtar kelimeler**: Mimiklerin fonksiyonu, hafızada bilgi tutma, şekilsel bilgi, şekilsel konuşma, şekilsel mimikler, işaret mimikleri, çocuklar, yetişkinler

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# Chapter 1

## INTRODUCTION

People move their hands while speaking in coordination with the content of their speech. These meaningful hand movements-called co-speech gestures- are an integral part of human communication in all cultures and ages. Why people make these hand movements is a matter of concern in the literature. So far, the literature has shown that such gestures serve two main functions. The first function of these gestures is to serve as a communication tool like language, namely, to guide interactions between people (see Kendon, 2004 for a review; Bavelas, Gerwing, J., Sutton, C., & Prevost, 2008 etc.). Another function of gestures is for the speaker. Support for this view comes from the findings which show that speakers still use gestures while speaking when there is no visual access to the listener; like gesturing while speaking on the phone (de Ruiter, 2003). Furthermore, it is found that blind speakers gesture as much as their sighted counterparts, even when they are talking to a blind person (Iverson & Goldin Meadow, 2001). These results, among others, which will be reviewed below show that gestures are helpful and necessary tools for the speaker to organize their own thinking.

Most previous studies have investigated the function of gestures for adult speakers, yet less is known about the different functions gestures serve for children (see Goldin-Meadow, 2004 for a review of studies with children). One of the

functions of gestures in adult speakers is to maintain spatial imagery in the memory while a person is speaking (Wesp et al, 2001, de Ruiter, 1998).The current thesis will investigate this claim in adults as well as in children (5 year olds) and explore the extent to which children and adults are similar or different in the memory maintenance function of gestures.

The current thesis will examine the use of iconic gestures and deictic gestures to maintain imagery in memory in expressions of spatial information. Iconic gestures resemble their referents in terms of shape, size or movement (de Ruiter, 2003). For example somebody can trace the shape of a vase with two hands saying “there was a vase on the table". Deictic gestures indicate figure, direction or the location of the figure by pointing to actual locations or to locations in abstract space (de Ruiter, 2003). Thus iconic or pointing gestures are likely to assist to maintain spatial information (such as shape, motion, location, direction) of the referent in memory. Iconic gestures are the most frequently used type of gestures while investigating memory maintenance function of gestures as used in experiments of Wesp et al., (2001), de Ruiter (1998) and Morsella and Krauss (2004). Even though the use of deictic gestures for memory maintenance so far has not been examined, their analysis will also be included here because points like iconic gestures can be also used in for memory maintenance especially when multiple referents are available during speaking as well as when their locations are also communicatively important.

# Chapter 2

# LITERATURE REVIEW

## *2.1 Functions of gestures for speakers: different hypotheses*

There are several hypotheses about the functions of gestures for the speaker in the literature. Two of the hypotheses about functions of gestures for the speaker are directly relevant and will be tested in the current thesis.[1] One of the most frequently studied hypotheses about the function of gestures is the lexical retrieval hypothesis which states that gestures are used to retrieve or access words during speaking. Another main hypothesis is the memory maintenance hypothesis which claims that gestures help keep images in working memory during speaking. Even though these two functions are somewhat linked to each other, they can be also viewed as two different functions of gestures for the speaker as will be explained below.

Another function of gestures mentioned in the literature is "Information packaging hypothesis" which will not be directly tested in this study, however, to understand the big picture about the functions of gestures for the speakers I also explain this function below.

[1] Note that there have been also other speaker-oriented functions of gestures for the speaker such as the 'reducing cognitive load" , 'helping learning ' (Goldin-Meadow, 2006) . According to these views gesture reduces cognitive load during thinking or problem solving .This view will not be directly tested in the current thesis.

### *2.1.1 Lexical Retrieval Hypothesis*

The first hypothesis about the function of gestures for the speaker is that gestures play an important role in lexical retrieval. According to this view, gestures are made during lexical search and play a role in the retrieval of speech (Morsella & Krauss, 2004; Krauss & Morsella, 2002). Evidence for this view comes from studies which show that the restriction of gestures has an adverse effect on the content and fluency of speech as well as on lexical retrieval and free recall (Frick-Horburry & Gutentag, 1998; Rauscher et al, 1996; Morsalla & Krauss, 2004). Also in accordance with this view, there are other findings which show that gestures occur more frequently when there is a breakdown in speech (cited in Frick Horburry, 2002). These results indicate that gestures are used in the conditions when lexical search is needed to maintain fluent speech. Krauss and Morsella (2002) have proposed a Gestural Feedback Model to illustrate the function of gestures in lexical retrieval. According to this model, gesturing activates and sustains semantic representations of tangible concepts and directly affects the retrieval of these concepts through cross-modal priming. According to Gestural Feedback Model there are two main levels of lexical retrieval during word production. In the first level, semantic and syntactic properties of the word– which are called “lexical node”- is selected. For example in the retrieval of the word “cat”, a lexical node of “Four legged, one tailed animal which has the sound of “meow” and which is a singular noun” is activated. During lexical retrieval of the word “cat”, lexical nodes for lion, rabbit or tail are also activated. Cat is selected because it has the highest number of activated nodes. In the second level of lexical retrieval, the word's phonology is retrieved. According to Morsella and Krauss (2002), iconic gestures re-activate the lexical nodes which

mostly include sensori-motor features of the word and they facilitate retrieval by sustaining the activation of those nodes long enough so that phonological encoding can happen. That's why people gesture more when they speak spatially.

In their study Morsella and Kraus (2002) found that people gestured more when the spatial content of their speech is rich. They needed to use gestures to retrieve and sustain sensori-motor features of the word.

This hypothesis which proposes that gestures have a direct role in providing necessary words for the speaker will be called the lexical retrieval hypothesis (it is referred as 'encoding' hypothesis in de Ruiter, 1998).

One problem for this hypothesis comes from the findings that both children's and adults' gestures can show aspects of their representations which are not necessarily expressed in their speech (Goldin-Meadow, 2003; Pine et al , 2006). For example, when children explain how they solved an addition problem, they may make an equation sign with their hands, which they never state in their explanations (cited in Goldin Meadow, 2000). Similarly, in a mental rotation task it was found that some of the solution strategies were showed in the gestures of people but not expressed in their speech (Ehrlich et al., 2006). Adults also have been shown to represent information not expressed in their speech. For instance, when they describe an action, although they never mention the direction of the movement in terms of left-right, their gestures represent the direction accurately (Kita and Özyurek, 2003). These studies showed that meanings of the gestures which are referred to spatial

elements may not be stated in the speech. Therefore, the function of gestures is not solely lexical retrieval-since in the case reported above producing gestures did not cause retrieval of the lexical items. Even though gestures might still facilitate the retrieval of concepts, they also serve other functions for the speaker. This other function can only be found when lexical retrieval function of gestures is controlled. In my thesis I aim to control lexical retrieval function of gestures and to show gestures may have another function for the speaker which is memory maintenance. How I will make this control is going to be stated in the following parts of my thesis.

### *2.1.2. Maintenance Hypothesis*

An alternative view of the function of gestures for the speaker is that gestures maintain spatial imagery in working memory and with this information in working memory, the lexical retrieval of spatial words is facilitated (Wesp et al, 2001; de Ruiter, 1998). According to Wesp et al. (2001), repetitive motor activity can maintain spatial information in the working memory much like rehearsal maintains words in the phonological loop of working memory. They suggest, unlike lexical retrieval hypothesis, that gestures are not directly involved in lexical search, rather they maintain the spatial imagery of lexical concepts in memory. Gestures maintain the information about to be described objects in the memory, rather than directly affecting lexical retrieval by activating lexical nodes. So, when there is an external memory aid, it is meaningful that people use less gesture than when there is not an external memory aid. In the without memory aid situation people use gestures as the aid to maintain information about to be described concepts. With this maintained information, the facilitation of the lexical retrieval might happen but is not the

primary function of gesture. Even though, lexical retrieval does not occur, gestures may maintain spatial information in the memory. The only way to find this is to control for the effect of lexical retrieval and then try to find support for memory maintenance.

In their experiment, Wesp et al. required their participants to describe a painting either by looking at the painting or from memory. If gestures have a role in maintaining spatial imagery, there should be more gesturing when the picture is described from memory. In support of this view, they found that gestures are used less when to-be-described information is present than when it is absent. When the image is present, there is no need to maintain the image in the memory because picture itself is already a memory aid. Thus, less gesturing is necessary when the image is present than when it is absent. These findings were also replicated by De Ruiter (1998) with a similar experiment.

Furthermore, De Ruiter (1998) did another experiment to show that gesture aids spatial memory but crucially has no direct role in speech production-disproving the lexical retrieval hypothesis. In that experiment, he asked participants to describe pictures that were either hard or easy to describe. Pictures were present for all participants, so the memory aid function of gestures was controlled. If gestures have a direct role in lexical retrieval then more gesturing should be done in describing difficult pictures because while describing difficult pictures more lexical search is needed. In other words, words about difficult concepts are expected to come to mind with more difficulty, so more lexical search is done. De Ruiter found no difference in

the amount of gesturing during the description of difficult or easy words. Thus, his findings did not support the lexical retrieval hypothesis which claims that gesture facilitates lexical retrieval. As a result, he reached the conclusion that lexical retrieval is not the only role of gestures.

Hence, both Wesp et al, (2001) and de Ruiter (1998) found support for the spatial aid function of gestures. However one weakness in their study is they did not completely eliminate the function of lexical retrieval, since we do not know about the content of their speech. Spatial speech may be higher in without memory aid condition and that may be the reason why gestures are high in that condition. In order to come to conclusion that gestures maintain spatial imagery, conditions in which spatial content is similar should be compared. The assumption that gesturing provides imagistic information about target words by maintaining imagery in spatial memory will be called the maintenance hypothesis in this paper (It is referred as the 'retrieval' hypothesis in de Ruiter, 1998).

### *2.1.3. Information Packaging Hypothesis*

As explained in Alibali et al (2000) this hypothesis states that gestures play role in the conceptual planning of the message which is to be conveyed. This means gesture helps speakers to ''package'' information into units to speak in ease. (Kita & Ozyurek, 2003). In other words, speakers use gestures to organize spatial and perceptual information. The more complex the information, the more conceptualization people need during their speech. If they need more conceptualization they will need more gestures to use in their descriptions (Alibali et

al, 2000). Therefore people need more gestures when the information to be conveyed include more complex items (Alibali et al, 2000). For example, Alibali et al (2000) found that children used gestures more during the explanations of complicated objects. Briefly according to the information packaging hypothesis, gestures are used in conceptual planning of utterances.

*2.2 The present study*

The maintenance of spatial information is then an alternative function of gestures for the speaker as opposed to the lexical retrieval function. Previous studies have tested the maintenance hypothesis against the lexical retrieval hypothesis among adults (De Ruiter , 2003), but it is not clear whether gestures also play a role in memory maintenance for children and how this role would compare to a similar function in adults. It is possible that children have smaller working memory than adults and they might need to use gestures more frequently than adults.

To find out whether gesture plays a role in memory maintenance for children and adults, a similar task to the one used by Wesp et al. (2001) and De Ruiter (1998) was used. Adult and child participants were asked to talk about simple events when the objects which were being described were available to the speakers and when they were not available. One crucial difference of this task to that of Wesp et al. (2001) and De Ruiter (1998) is that the stimuli in the current thesis included moving objects- unlike still pictures as used in previous studies. Previous studies tested the role of gestures in maintaining spatial information of static elements like figure or ground. The reason for me to choose moving elements is to see whether gestures play a role

in maintaining information about moving objects and their directions as well as static elements, So, different from previous studies, the function of gesture to maintain movement of objects was targeted in addition to their locations and relations etc. Furthermore in the condition where subjects were asked to narrate to what they had seen in the condition where the objects being described were available to the speakers, only the objects from the vignettes were shown in a still picture without any further visible aid about their movement.

5-year-old children and adult participants watched 10 short vignettes which included motions of two objects in the shape of a circle and a triangle (Ozyurek, Kita, Allen, 2000; Tomato Man vignettes that have been used for gesture and speech elicitation with children). After watching the vignettes, the participants were required to narrate what they watched to a listener who did not know the content of the vignette. Thus, the communicative role of gesture was the same for all participants. Half of the participants (*with-picture* condition) described the vignettes with a picture in front of them (but in a way can not be seen by the addressee) that contains elements in the vignette and half described without that picture (*no-picture* condition). In the with picture condition after participants watched the vignette, media player in the computer was closed and picture was put in front of the computer screen where the listener can not see the picture. In no picture condition, media player in the computer was also closed after the participant watched the vignette (See figure 1,2 and 3 in the appendices for the layout of the experiments). In both conditions the listener did not see either the vignettes or the pictures. All narrations were videotaped. Thus if gestures help to maintain memory of items we expected

speakers in the *no-picture* condition will use more gestures than in the with-picture condition. In order for this difference to be due to memory maintenance, content of the spatial speech in the conditions should be similar. If the content of the spatial speech is similar in the conditions, and if I will find gesturing is high in the no picture condition, this will mean high gesturing does not elicit more spatial speech, so more gesturing may not be a help in retrieval of spatial concepts. So we can reach the conclusion that gestures were used as a memory aid in the condition in which memory aid is not present. In order to maintain this similarity spatial content of the speech in the conditions will be compared. If the spatial content is similar then gesture numbers will be compared. If spatial content is not similar, the cases in which spatial content is similar will be identified and gesture numbers of those cases will be compared.

However one potential confound variable in using simply these two main conditions for both adults and children is that communicative situation in the *with-picture* condition might be interpreted differently by adults and children. For example even though the listener doesn't see the picture in front of the child, there is a possibility that children would not take this into account in their narrations as adults would (Matthews, Lieven , Theakston and Tomasello, 2006). Adults would possibly adjust their narratives knowing that the listener can not see the picture. However children might assume that listener has the knowledge of the picture they are seeing ( i.e., for example not being able to take the perspective of the listener) and they might keep pointing to the pictures in front of them even though the listener can not see them. In a study it was found that children's ability to chose

different expressions depending on whether their addressee could see the intended referent or not changes according to the age of the children (Matthews et al, 2006). Knowing this, children might differ in their expressions in speech and gesture than adults in the with-picture condition. The number of gestures used by adults and children in this condition might differ as a result of children's deficiency in the perspective taking and not necessarily as a result of the difference in the need for the memory maintenance function of gestures.

In order to be able to check for this potential confound, and to make sure that children can differentiate a condition where they have the pictures available only to them from another condition where pictures are available to both themselves and the listeners, I had an extra condition: *with-picture visible to listener.* I will investigate whether children can understand the difference between with picture conditions as adults do or not. If I find that adults and children respond in the same way to the both of the with picture conditions in terms of speech and gesture, then I can be sure that children's responses can be compared to those of adults in the *with-picture* condition ( i.e., when the picture is visible only to the child but not to the listener).

Thus to summarize, overall the study had three conditions; *no picture, with-picture not visible to listener* ( i.e., available only to the speaker) and *with-picture visible to listener* ( as well as to the speaker). Among these, the first two were crucial to test the maintenance hypothesis in children and adults, and the third one was

necessary to make sure that children interpreted the communicativeness of the situation (with-*picture*) in same way as adults.

*2.3. Predictions*

To test the maintenance hypothesis, I will compare the no-picture condition with the other two with-picture conditions (i.e., with-picture not visible to the listener and with-picture visible to listener condition) in terms of amount of gesturing. One of the main predictions for adults is that, if the memory maintenance hypothesis is correct, and if gestures maintain spatial imagery in spatial memory, there will be more gesturing during descriptions of stimuli in the no-picture condition than the with-picture conditions. If the maintenance hypothesis is also correct for children, I expect similar results for children. Furthermore, it is possible that children have smaller working memory capacity than adults since developmental growth in working memory capacity from childhood to adolescence has been documented in the literature (Gathercole et al, 2004; Roncadin et al, 2007). Based on the knowledge that children have less developed working memory capacity compared to adults, they are expected to rely on gestures more in the no-picture condition. So, it might be expected that the difference in gestures between conditions will be greater for children than for adults.

Furthermore within the two with-picture conditions, I predict that five-year-old children will interpret the difference between *with-picture visible to listener* versus *with-picture* (not visible to the listener) conditions) as adults do. Previous research on children's perceptive taking abilities in such tasks (Flavell et al, 1981)

show that children can take the perspective of others in simple tasks, such as when a card is put vertically between an adult and a child, children can understand which side of the card the adult is seeing. According to the Flavel et al (1981)'s study, even 3-year-old children were successful in the perspective taking ability tasks and they can understand the perspective of others. In addition to that in the same study they also found 3-year-old children can develop the perspective taking ability with training and with this training they can also be successful in the more difficult tasks. In another study it was found that 3- and 4-year-old children can understand whether addressee can see the referent or not and they adjust their expressions accordingly (Matthews et al, 2006). In my study, to test whether children can understand the perspective of adults or not, the amount of deictic gestures will be compared among with picture conditions. Thus, it is predicted that for both children and adults, there will be fewer pointing gestures in the *with-picture* not visible to the listener condition than in *with-picture visible to the listener* condition since it is expected that participants will prefer to point to the pictures when they are available to both. However, the proportions of iconic gestures might be the same in both with-picture conditions both in adults and children. If children do not choose to point to the picture when the picture is not available to the listener, and if they point to the picture when it is available to listener, this shows that children can understand whether the listener is seeing the picture or not and they adjust their actions accordingly. If I will find fewer pointing gestures in the *with-picture* not visible to the listener condition than in *with-picture visible to the listener* condition, I will ensure that adult and children interpret the *with-picture* not visible to the listener condition in the same way as with-picture visible to the listener.

Finally to be able to differentiate the maintenance hypothesis from the lexical retrieval hypothesis I will look for the content of the speech in the no-picture and with-picture conditions. To do this, the spatial content of the speech of the participants will be identified in each condition. If adult and child speakers use more gestures in the no-picture condition than in the with-picture conditions when the spatial content of speech is similar, this will provide more concrete evidence for the memory maintenance hypothesis. If the content of speech is similar for all conditions, the only explanation for the difference in the number of gestures between two conditions can be attributable to the maintenance hypothesis, because the function of gestures for lexical retrieval will be kept constant.

*Pilot study*

Prior to the main study, a pilot analysis was made to test some of these hypotheses. The iconic gestures of 30 Turkish adults who saw the same cartoons that we used in this study were examined. These data came from another study originally collected to examine gesture patterns cross-linguistically. Ten of the speakers told the cartoons in the no-picture condition and twenty in the with -picture condition (picture visible to the listener). An ANOVA with condition as a between subjects factor revealed main effects of condition on the number gestures, $F$ (1, 28) = 8.231, $p$ = .008 (partial eta squared = .227) revealing that adults used more gestures in the absence of pictures than in the presence as predicted by Wesp et al (2000) and de Ruiter (1998). However in this pilot study (which was based on a set of studies that were prepared to investigate other phenomena), addressee's knowledge of the content of the vignettes was not held constant. In the no-picture condition addressees

had not seen the vignettes like the speaker whereas in the with-picture condition the speakers had also watched the vignette together with the addressee. So there was also a confound of shared knowledge in addition to the visibility of the pictures. And thus the effect of more gesturing in the no-picture condition can also be attributed to the fact that addressees have not seen the vignette and the speaker might think they need more visual representations to imagine the scene. In the study conducted for the thesis we made sure in all conditions the addressee did not watch the vignettes with the speaker.

# Chapter 3

# METHODOLOGY

## *3.1. Participants*

25 Turkish five-year-olds and 28 Turkish adults were the participants. Child participants were chosen from three kindergardens in Sarıyer, İstanbul named Pembeköşk Anaokulu, Pusula Çocuk Evi and İzci Çocuk Yuvası. Before going to the kinder gardens, 5 kinder gardens were called, and asked for permission. Three of them whose names were stated gave permission for the experiments. The aim and the content of the experiment were explained to the heads of the kinder gardens before the experiment.

Adult participants were the students in the Introduction to Psychology course in Koç University. They participated in the experiment and got credit in the course. 8 of the children and 9 of the adults were in the *no-picture* condition which is *condition 1*; 9 of the children and 9 of the adults were in the *with-picture visible to the listener condition* which is *condition 2*; remaining 8 of the children and 10 of the adults were in the *with-picture not visible to the listener condition* which is *condition 3*. The children's ages were between 4,21 and 5,79. The adults' ages were between 18 and 22. The means of ages of children and adults across conditions can be seen in table 3.1.

**Table 3.1**

*Mean (SD) of ages of participants across the conditions*

| | No-picture condition | With-picture visible to listener condition | With-picture not visible to listener condition |
|---|---|---|---|
| Adults | 19.89(1.17) | 20(1.58) | 20.1(1.20) |
| Children | 5.32(0.51) | 5.03(0.47) | 5.16(0.54) |

*3.2. Procedure*

Participants watched 12 short vignettes which include movements of two objects which have the shapes of circle (red) and triangle (green). The first two of them were practice vignettes. The coding was done for the following ten vignettes which come after the two practice vignettes. Movements of circle and triangle included roll, jump, hit, go with the directions of left, right, up and down. After each vignette, the participants were required to describe what has happened in the vignette to the listener. They were informed that the listener did not know the content of the vignette. (See figures 4 to 13 in appendices for the pictures that were available to speakers and/or addressees in the with-picture conditions during the telling)

Content of each vignette was as follows;

Vignette 1: Triangle hits tomato. Tomato rolls up the hill and then falls down on the sea.

Vignette 2: Tomato comes on the hill. Then it falls down on the sea near the triangle while rotating.

Vignette 3: Triangle goes up the hill while jumping, then passes in front of the tomato.

Vignette 4: Triangle goes down the hill while rolling and then passes in front of the tomato.

Vignette 5: Triangle hits tomato. Tomato rolls down the hill and then hits a tree.

Vignette 6: Tomato and triangle come near a tree. Triangle goes around the tree while jumping. Then it comes near the tomato and both of them leave.

Vignette 7: A tomato holds a banana. Then it goes down the hill while jumping. Then it gives the banana to the other tomato.

Vignette 8: Triangle jumps. Then tomato moves up from the sea while rolling. Then it comes near the triangle and they live together.

Vignette 9: Tomato and triangle enters the scene. Triangle rolls up the hill. Then tomato moves up the hill. Then both of them leave the screen.

Vignette 10: Triangle moves down on the sea while rolling. Then tomato moves down next to the triangle.

The listener for the experiment was chosen among the Koç University students in the adult group. An announcement for the position was made via email. Among the applications, ten interviews were made. The one whose time was more available was chosen. For all experiments and for both children and adults the same listener (as a confederate) participated.

The experiments of children were held in an appropriate room of their kinder gardens in which necessary equipments were present. The experiments of adults were done in a lab at Koç University. Standard layout of the experiment which will be discussed in the next paragraph was sustained in the kinder gardens and the experiment room of Koç University.

The procedure of the experiment was the same for both adults and children. The experimenter, the participant and the listener sat around a table. The participant and the listener sat face to face on one side of the table. The computer in which the vignettes were shown was in front of the participant. In the no-picture condition, the computer screen was in front of the participant in such a way that the listener could not see the vignettes. This setting ensured that speaker prevented from describing the vignettes using the computer screen. The experimenter sat behind the participant. Once each vignette was viewed the screen went blank and the experimenter closed the lap top. In the with-picture not visible to the listener condition, for half of the participants the picture were put on the computer screen for only the participant to see during descriptions after he viewed the vignettes. For the other half of the participants, that was in the with-picture visible to the listener condition, the picture was placed between the listener and the participant in a position where both the participant and the listener were able to see the picture. The picture used in the with picture conditions was the first scene of each vignette. (See figure 1,2 and 3 in appendices for the design of the experiment for three conditions)

Before the descriptions, instructions were given to the participants in order to make sure that they understand what they will do. The same instructions were given to all participants. These instructions were:

For **no-picture** condition:

"12 tane kısa çizgi film seyredeceksin. Bu çizgi filmlerde biri kırmızı domates, diğeri de yeşil üçgen olmak üzere 2 tane ana karakter var. Çizgi filmler bu iki karakterin yaptığı hareketleri içermektedir. Her bir çizgi filmi izledikten sonra, görüntüyü kapatacağım ve o çizgi filmi karşında oturacak olan kişiye anlatmanı istiyorum. Dinleyecek olan kişi, çizgi filmi daha önce hiç seyretmedi ve sen izlerken de çizgi filmi görme şansı olmayacak."

"You are going to watch 12 small vignettes. These vignettes have the characters of red tomato and green triangle. Vignettes include actions of these characters. After you watched each vignette, I will close the scene and I want you to describe what you saw in the vignette to the person who sits across you. She did not watch the vignette before and do not know the content and she will not be able to watch while you are watching."

For **with-picture not visible to the listener** condition:

"12 tane kısa çizgi film seyredeceksin. Bu çizgi filmlerde biri kırmızı domates, diğeri de yeşil üçgen olmak üzere 2 tane ana karakter var. Çizgi filmler bu iki figürün yaptığı hareketleri içermektedir. Her bir çizgi film oynadıktan sonra, filmden bir sahne gösteren bir resmi senin önüne bilgisayar ekranının üzerine

koyacağım. İzlediğin çizgi filmi karşınızda oturacak olan kişiye anlatmanı istiyorum. Anlatırken resme bakıp, yardım alabilirsin. Dinleyecek olan kişi, çizgi filmi daha önce hiç seyretmedi ve sen izlerken de çizgi filmi görme şansı olmayacak."

"You are going to watch 12 small vignettes. These vignettes have the characters of red tomato and green triangle. Vignettes include actions of these characters. I will close the scene and I want you to describe what you saw in the vignette to the person who sits across you. After you watched each vignette, I will put a picture in front of you, on the computer screen which shows a scene from the vignette. While describing, you can look at the picture. The listener did not watch the vignette before and do not know the content and she will not be able to watch while you are watching.

For **with-picture visible to the listener** condition:

"12 tane kısa çizgi film seyredeceksin. Bu çizgi filmlerde biri domates, diğeri de üçgen olmak üzere 2 tane ana karakter var. Çizgi filmler bu iki figürün yaptığı hareketleri içermektedir. Her bir çizgi film oynadıktan sonra, çizgi filmden bir sahneyi içeren bir resmi dinleyiciyle senin arana koyacağım. İzlediğiniz çizgi filmi karşınızda oturacak olan kişiye anlatmanı istiyorum. Anlatırken resme bakıp, yardım alabilirsin. Dinleyecek olan kişi, çizgi filmi daha önce hiç seyretmedi ama resim aynı zamanda onun da önünde olduğu için sen izlerken o da resme bakabilir."

"You are going to watch 12 small vignettes. These vignettes have the characters of red tomato and green triangle. Vignettes include actions of these characters. I will close the scene and I want you to describe what you saw in the

vignette to the person who sits across you. After you watched each vignette, I will put a Picture between you and the listener which shows a scene from the vignette. While describing, you can look at the picture. The listener did not watch the vignette before and do not know the content and she will not be able to watch while you are watching. However while you are describing she can look at the Picture too.

### *3.3. Measures*

Measures or speech and gesture were identified separately. For both measures the expressions of spatial content were chosen in additional to general ones ( i.e., number of all words and all gestures). For speech general spatial words as well as indexicals such as demonstratives (bu, su, o) were identified separately as well as in a combined category. Similarly for gestures iconic gestures as well as points were identified and quantified.

#### *3.3.1. Speech Coding*

For each vignette all the words participants said were written as each sentence is in one line. Then *for* each sentence spatial speech was identified and written separately. Then all words and spatial words were counted.

#### *3.3.2. Gesture Coding*

For each vignette all the gestures were identified. For coding iconic gestures following criteria was used; non-rhythmic, spontaneous hand and finger movements that represents a spatial element. For coding deictic gestures following criteria was used; finger, arm or head movements that points to a spatial object on the picture, computer screen or neutral space. Shape of the hand movement was written as the

first step of coding. Then the meaning of that hand movement is written. Then the type of gesture is identified. Examples of speech and corresponding gesture coding for an adult and a child participant during the explanation of a vignette can be seen in figures 14 and 15, respectively.

*Figure 14: Speech and corresponding gesture coding sample for an adult during the explanation of a vignette*

| **Speech Coding** | | **Gesture Coding** | | |
|---|---|---|---|---|
| **Transcription** | **Spatial Speech** | **Corresponding Gesture** | **Meaning** | **Type** |
| burda yine düz geldi | burda düz geldi | Right hand index moves to left | go left | iconic |
| durdu burda | durdu burda | | | |
| ondan sonra kendi etrafında döne döne üçgenin yanında durdu | etrafında döne döne üçgenin yanında durdu | Right hand index moves down while rolling | go down | iconic |
| | | Right hand index points to picture | triangle | deictic |
| | | Right hand index points to pic | tomato | deictic |
| **Speech Variables** | | **Gesture Variables** | | |
| Number of all words=15<br>Number of combined spatial words=11<br>Number of demonstrative spatial words=2<br>Number of non-demonstrative spatial words =9 | | Number of iconic gestures=2<br>Number of deictic gestures=2<br>Number of all gestures =4 | | |

*Figure 14: Speech and corresponding gesture coding sample for a child during the explanation of a vignette*

| **Speech Coding** | | **Gesture Coding** | | |
|---|---|---|---|---|
| **Transcription** | **Spatial Speech** | **Corresponding Gesture** | **Meaning** | **Type** |
| şimdi şimdi domates denizdeydi | domates denizdeydi | rh points to the picture | tomato | deictic |
| sonra domates havaya gitti | domates havaya gitti | rh moves up | go up | iconic |
| sonra oraya geldi | oraya geldi | rh moves to right | go right | iconic |
| üçgenle gittiler yine yana | üçgenle gittiler yana | rh moves to right | go right | iconic |
| **Speech Variables** | | **Gesture Variables** | | |
| Number of all words=15<br>Number of combined spatial words=10<br>Number of demonstrative spatial words=1<br>Number of non-demonstrative spatial words =9 | | Number of iconic gestures=3<br>Number of deictic gestures=1<br>Number of all gestures =4 | | |

*3.3.3. Measures of Speech Analyses*

To be able to find out whether speech content was affected by conditions and was similar or not for children and adults (i.e., to be able to dissociate lexical retrieval from memory maintenance hypothesis) I analyzed the use of general as well as spatial words (demonstrative and non-demonstrative words). For speech analysis, number of all words, proportion of non-demonstrative spatial words in all words, proportion of demonstrative spatial words in all words and proportion of combined spatial words (demonstrative and non- demonstrative) in all words were the independent variables as will be explained below in further detail .

*Number of all words:* This is the number (tokens) of all words (spatial or non-spatial) used by each participant used during the descriptions. Later means of the number of words for each age group and condition were calculated.

*Proportion of non-demonstrative spatial words in all words:* In order to calculate this variable, non-demonstrative spatial words (e.g., come, descend etc.) were firstly identified among all words. While deciding which word is spatial or not the criteria was the word should represent a concrete spatial image in the people's mind, such as a figure, ground, activity, motion, direction of the motion and location. Adjectives which show the degree of spatial movement was regarded as spatial, too. The words which were not regarded as spatial were facial resemblances like "smile, happy or unhappy", conjunctions such as "and, or, like, with". Neutral verbs which do not represent a movement and an action such as "do, make" were not regarded as action either. If these neutral verbs were used with a spatial concept such as "make a circle" then they were counted as spatial, too. The list of spatial words which were seen most in the descriptions can be seen in table 3.2.

**Table 3. 2**

*Types of Spatial Words in the Descriptions*

| **Object names:** | **Spatial Nouns:** | **Action and Motion Verbs:** | **Ground names:** | **Adjectives** | **Demonstrative words:** |
|---|---|---|---|---|---|
| Domates adam, üçgen adam, muz, ağaç, kafası, eli, daire, çiçek, göz, surat, nesne, şekil parça | yukarı, aşagı, ön, arka, üstü, altı, içi, yanı, etrafı, arkası, boş, sağ, sol, düz, kenar, tersi, yön, baş, son, yokuş, düzlük, dikdörtgen, boşluk, hiza, kare, kısım, köşe, tüy, hiza, dışar, orta, bitim, bitiş, manzara, görüntü, kısım, dikdörtgen, kare, tüy, blok, gölge, çıkıntı, ardından | gelmek, gitmek, girmek, düşmek, çıkmak, inmek, almak, vermek, götürmek, itmek, yuvarlanmak, dönmek, zıplamak, durmak, tutmak, atlamak, yüzmek, takip etmek, yokolmak, kaybolmak, kaymak, sıkıştırmak, oturmak, kalkmak, sürünmek, kaktırmak, kaymak, çekilmek, koymak , takıl, ilet, kalmak, tur atmak, hareket etmek/başlamak , tırmanmak, birleşmek, uzaklaşmak, yerinde saymak, geçmek, yükselmek, çarpmak, hiza çekmek, tur tamamlamak, salınmak, el ele tutuşmak, saklanmak, bırakmak, dolanmak, sağlamak, yatırmak, hareket etmek, ayrılmak, toslamak, batmak, birleşmek | yer, deniz, su, tepe, dağ, hava, tahta, duvar, yüksek, uç, yükseklik, yamaç, ortam, kara, yüzey, sahne, alan, kat, düzenek, çevre | Hızlı, yavaş, hafif, büyük, meyilli | Pronouns of “o, bu, şu,” and “bura, ora, şura” , adverbs of” böyle, şöyle, öyle” |

After the non-demonstrative spatial words were identified, proportion of them in all words was calculated as number of non-demonstrative spatial words divided by number of all words.

*Proportion of demonstrative spatial words in all words:* To calculate this proportion, demonstrative spatial words were identified. Demonstrative spatial words were the demonstrative words that refer to spatial elements. Demonstrative words that did not represent a spatial element were not counted as demonstrative spatial words. This number were identified because in the with picture conditions participants described while looking at the picture. So it is very possible that they use a demonstrative word to represent a spatial element especially when the listener is seeing the picture. Instead of saying the name of the spatial element, participant can use a demonstrative word and show it in the picture.

The list of demonstrative spatial words which were seen most in the descriptions can also be seen in table 2. Proportion of demonstrative spatial words were calculated by dividing the number of demonstrative spatial words by number of all words.

*Proportion of combined spatial words (demonstrative and non- demonstrative):* This variable combined demonstrative and non- demonstrative spatial words and their number was divided by number of all words.

### *3.3.4. Measures for Gesture Analyses*

For gesture analyses the number of all gestures, proportion of all gestures in all words, proportion of iconic gestures in all words, proportion of deictic gestures in all words, proportion of iconic gestures in combined spatial words, and proportion of

deictic gestures in combined spatial words, proportion of deictic gestures in demonstrative words and proportion of iconic gestures in non demonstrative words were calculated for comparison across conditions and age.

*Number of all gestures:* This is the number (tokens) of all gestures (iconic and deictic) used by each participant used during the descriptions. Later means of the number of gestures for each age group and condition were calculated.

*Proportion of all gestures in all words:* In order to calculate this, number of iconic and deictic gestures were summed and then divided by all words.

*Proportion of iconic gestures in all words:* In order to calculate this proportion number of iconic gestures was calculated. Gestures which represent shape of the referent were counted as iconic gestures. Gestures which are made on the picture (e.g., tracing a path of motion)– except point gestures – were also calculated as iconic gestures. Proportion of iconic gestures in all words were calculated as number of iconic gestures divided by number of all words.

*Proportion of deictic gestures in all words:* Firstly number of deictic gestures was calculated. Gestures regarded as deictic were one single point actions to picture, computer or neutral space. These point actions were calculated. This number was divided by number of all words.

*Proportion of iconic gestures in combined spatial words:* Number of iconic gestures divided by number of combined spatial words .

*Proportion of iconic gestures in non-demonstrative spatial words:* To calculate this proportion the number of iconic gestures was divided by the number of non-demonstrative spatial words.

*Proportion of deictic gestures in combined spatial words:* To calculate this proportion the number of deictic gestures was divided by the number of combined spatial words.

*Proportion of deictic gestures in demonstrative spatial words:* To calculate this proportion the number of deictic gestures was divided by the number of demonstrative words.

# Chapter 4

# RESULTS

## *4.1. Speech analysis*

For the analysis of speech, the number of all words, the proportion of combined spatial words in all words, the proportion of non-demonstrative spatial words in all words and the proportion of demonstrative spatial words in all words were calculated for each subject and these numbers were compared in terms of group and age .

First of all, in order to see and compare the number of words children and adults used a 2x3 ANOVA was conducted on *the number of all words* as a dependent variable and age and condition (with-picture visible to listener, with-picture not visible to listener and no-picture) as independent variables. The analysis showed that, the number of words adults used is significantly higher than the number of words children used. There was a main effect of age $F(1,47)= 40.902$, $p<0.001$. The analysis also showed that there is significant difference between conditions in terms of number of all words used $F(2,47)=4.883$, $p=0.012$. Analysis did not reveal significant interaction between age and condition $F(2,47)=2.582$, $p=0.086$. Post hoc analysis showed that in with picture not visible to listener condition, adults and children used more words than in the with picture visible to listener condition. There was no significant difference between no picture and with picture visible to listener $p=0.081$, and with picture not visible to listener $p= 0.795$. Means of *the number of all wo*rds in children and adults can be seen in table 4.3.

**Table 4.3**

*Mean (SD) of the number of all words used in the descriptions*

| | No-picture condition | With-picture visible to listener condition | With-picture not visible to listener condition | Totals |
|---|---|---|---|---|
| Adult | 341.22(91.7) | 209(47.532) | 403.40(223.05) | 320.93(163.03) |
| Child | 130.88(57.103) | 105.67(22.282) | 135.25(36.55) | 123.20(41.11) |
| Totals | 242.24(131.694) | 157.33(64.213) | 284.22(213.747) | 227.66(156.56) |

Secondly in order to check if the spatial content across conditions and ages is similar or not, I compared proportions of spatial words across conditions. 2x3 ANOVA was conducted on *proportion of combined spatial words in all words* as dependent variable; age (child and adult) and condition (3 conditions) as independent variables. Analysis *showed that this number is significantly higher in children than adults',*$F(1,47)=31.49$*,* $p=0.00$. However, this ratio was not different across conditions, $F(2,47)=1.82$*,* $p= 0.17$ in adults of children. Analysis did not reveal significant interaction between age and condition, $F(2,47)=1.40$*,* $p=0.26$. Means of the *proportion of combined spatial words in all words* in children and adults can be seen in table 4.4.

**Table 4.4**

*Mean(SD) of proportion of combined spatial words in all words (%)*

| | No-picture condition | With-picture visible to listener condition | With-picture not visible to listener condition | Totals |
|---|---|---|---|---|
| Adult | 60.34(4.65) | 66.17(7.40) | 60.60(7.36) | 62.31(9.93) |
| Child | 71.02(9.31) | 75.26(10.56) | 78.21(8.04) | 74.85(9.49) |
| Totals | 65.36(8.89) | 70.71(10) | 68.43(11.68) | 68.22(10.32) |

Thirdly, 2x3 ANOVA was conducted on *proportion of non-demonstrative spatial words in all words* as dependent variable; age (child and adult) and condition as independent variables. Analysis showed this proportion is significantly higher in children than adults', $F(1,47)=14.72$, $p<0.001$. It was not different across conditions, $F(2,47)=0.90$, $p=0.41$. Analysis did not reveal significant interaction between age and condition, $F(2,47)=0.91$, $p=0.41$. Means of *proportion of non-demonstrative spatial words in all words* for children and adults can be seen in table 4.5.

**Table 4.5**

*Mean (SD) of proportion of non-demonstrative spatial words in all words (%)*

| | No-picture condition | With-picture visible to listener condition | With-picture not visible to listener condition | Totals |
|---|---|---|---|---|
| Adult | 56.62(6.45) | 56.8(6.61) | 56.72(7.89) | 56.71(6.79) |
| Child | 65(9.88) | 63.93(16.2) | 71.99(7.76) | 66.85(12.07) |
| Totals | 60.56(9.06) | 60.37(12.50) | 63.51(10.9) | 61.50(10.83) |

Finally 2x3 ANOVA was conducted on *proportion of demonstrative spatial words in all words* as dependent variable; age (child and adult) and condition as independent variables. Analysis showed that children's proportion of demonstrative spatial words in all words is not different from adults, $F(1,47)=1.37$, $p=0.25$. This number was significantly different across conditions. $F(1,47)=3.69$, $p=0.03$. However post hoc analysis has indicated that between any of the conditions there is no significant difference. Analysis did not reveal significant interaction between age and condition $F(2,47)=0.004$, $p=0.995$. Means of *proportion of demonstrative spatial words in all words* for children and adults can be seen in table 4.6.

**Table 4.6**

*Mean (SD) of proportion of demonstrative spatial words in all words (%)*

| | No-picture condition | With-picture visible to listener condition | With-picture not visible to listener condition | Totals |
|---|---|---|---|---|
| Adult | 3.72(2.46) | 9.37(6.80) | 3.89(1.39) | 5.59(4.81) |
| Child | 6.02(4.20) | 11.32(11.88) | 6.22(8.47) | 7.99(8.92) |
| Totals | 4.80(3.49) | 10.35(9.44) | 4.92(5.65) | 6.73(7.09) |

*Summary of speech results*

In general speech analyses showed that adults and children treated the three conditions in similar ways. That is their speech was influenced in similar ways due to describing scenes in different conditions. Speech with spatial content did not show effect of condition for adults or children-except for demonstratives which were used marginally more in the with-picture visible to addressee condition than the other conditions by both adults and children. However adults in general differed from children in using more words to describe the events, while children used more non demonstrative spatial words than adults per word.

Since speech of adults and children responded similarly to the different conditions (non demonstrative spatial speech not being influenced at all by the different conditions and use of more demonstratives in the picture visible to addressee condition than the other conditions), one can attribute the possible changes in gesture to memory maintenance but not to lexical retrieval. Furthermore the results

also rule out the possibility that children interpreted the pragmatic aspects of the communicative situation in three conditions in different ways than adults. Next I compared with-picture conditions with no-picture condition, in terms of gesture use.

*4.2. Gesture Analyses*

For gesture analyses number of all gestures, proportion of all gestures in all words, proportion of iconic gestures in all words, proportion of deictic gestures in all words, proportion of iconic gestures in combined spatial words, and proportion of deictic gestures in combined spatial words, *proportion* of iconic gestures in non-demonstrative spatial words, proportion of deictic gestures in demonstrative spatial words were calculated for comparison across conditions and age.

To start the gesture analysis, I first compared *number of all gestures* between conditions and age. 2x3 ANOVA was conducted on *number of all gestures* as dependent variable; age and condition as independent variables. Analysis showed that adults' number of all gestures is significantly higher than children's. $F(1,47) = 25.10$, $p<0.001$. No effect of condition was found, $F(2,47)=0.834$, $p=0.441$. Analysis did not reveal significant interaction between age and condition, $F(2,47)=0.485$, $p=0.618$. Means of *numbers of gestures* for children and adults can be seen in table 4.7.

**Table 4.7**

*Mean(SD) of the number of all gestures used in descriptions*

| | No-picture condition | With-picture visible to listener condition | With-picture not visible to listener condition | Totals |
|---|---|---|---|---|
| Adult | 85.78(26.63) | 61.44(16.41) | 79.6(56.6) | 75.75(38.276) |
| Child | 32.75(33.83) | 27.22(22.57) | 25.13(29.95) | 28.32(27.853) |
| Totals | 60.82(39.997) | 44.33(26.009) | 55.39(53.305) | 53.38(41.112) |

Next we analyzed the use of **all gestures compared to use of words**- since the speech analyses have shown that adults used more words than children. A 2x3 ANOVA analysis was conducted on *proportion of iconic gestures in all words* as dependent variable; age and condition as independent variables. Analysis showed that this proportion was not significantly different across conditions, $F(2,47)=1.23$, $p=0.30$. This proportion was not significantly different between children and adults, either, $F(1,47)=1.58$, $p=0.22$. Analysis also revealed that there is no significant interaction between age and condition, $F(2,47)= 0.07$, $p=0.94$. Thus the overall use of gesture in relation to words used is really not different across ages or conditions. Means of the *proportion of iconic gestures in all words* for children and adults can be seen in table 4.8.

**Table 4.8**

*Mean (SD) of proportion of all gestures in all words (%)*

| | No-picture condition | With-picture visible to listener condition | With-picture not visible to listener condition | Totals |
|---|---|---|---|---|
| Adult | 25.25(6.51) | 29.75(7.24) | 20.85(15.05) | 25.13(10.84) |
| Child | 23.01(22.07) | 24.63(19.73) | 17.03(18.51) | 21.68(19.56) |
| Totals | 24.20(15.35) | 27.19(14.66) | 19.15(16.27) | 23.50(15.51) |

For deictic gestures, firstly a 2x3 ANOVA was conducted on *proportion of deictic gestures in all words* as dependent variable; age and condition as independent variables. Analysis showed that this number was significantly different across conditions, $F(2,47)=15.852$, $p<0.001$. Analysis also showed that this number was not significantly different between children and adults, $F(1,47)=1.11$, $p=0.3$. Analysis also revealed that there is no significant interaction between age and condition, $F(2,47)= 0.109$, $p=0.90$. Post hoc analysis showed that with picture visible to listener condition has significantly higher proportion of deictic gestures in all words than no-picture condition, $p<0.001$ and with picture not visible to listener condition, $p<0.001$. However, there was no significant difference between no picture condition and with picture not visible to listener condition $p= 0.29$. Means of *proportion of deictic gestures in all words* for children and adults can be seen in table 4.9.

**Table 4.9**

Mean(SD) of *proportion of deictic gestures in all words (%)*

| | No-picture condition | With-picture visible to listener condition | With-picture not visible to listener condition | Totals |
|---|---|---|---|---|
| Adult | 0(0) | 6.80(3.59) | 1.65(2.16) | 2.79(3.72) |
| Child | 0.61(0.93) | 7.71(7.15) | 3.39(3.75) | 4.06(5.52) |
| Totals | 0.29(0.69) | 7.26(5.51) | 2.42(3.01) | 3.38(4.66) |

Another 2x3 ANOVA was conducted on *proportion of deictic gestures in combined spatial words as* dependent variable; age and condition as independent variables. According to the analysis this number was significantly different across conditions, F (2,47)=15.85*, p*<0.00*1*. Analysis also showed that this number was not significantly different between children and adults, F(1,47)=1.11*, p=0.30.* Analysis also revealed that there is no significant interaction between age and condition, F(2,47)= 0.11, *p=0.90.* According to the post hoc analysis with picture visible to listener has significantly higher proportion of deictic gestures in combined spatial words than no-picture condition *p*<0.00*1* and than with picture not visible to listener condition. *p<0.001*. However, there was no significant difference between no picture condition and with picture not visible to listener condition *p= 0.29.* Means of *proportion of deictic gestures in combined spatial words* for children and adults can be seen in table 4.10.

**Table 4.10**

*Mean (SD) of proportion of deictic gestures in combined spatial words (%)*

| | No-picture condition | With-picture visible to listener condition | With-picture not visible to listener condition | Totals |
|---|---|---|---|---|
| Adult | 0(0) | 6.80(3.59) | 1.65(2.16) | 2.78(3.72) |
| Child | 0.61(0.93) | 7.71(7.15) | 3.39(3.75) | 4.06(5.52) |
| Totals | 0.29(0.69) | 7.26(5.51) | 2.42(3.01) | 3.38(4.66) |

2x3 ANOVA was conducted on *proportion of deictic gestures in demonstrative spatial words as* dependent variable; age and condition as independent variables. According to the analysis this number was significantly different across conditions, F (2,45)=7.5*, p*<0.00*1*. Analysis also showed that this number was not significantly different between children and adults, F(1,45)=0.11, *p=0.75.* Analysis also revealed that there is no significant interaction between age and condition, F(2,45)= 0.36, *p=0.7.* According to the post hoc analysis with picture visible to listener has significantly higher proportion of deictic gestures in demonstrative spatial words than no-picture condition *p*<0.00*1*. There was no significant difference between no picture condition and with picture not visible to listener condition and between with picture visible to listener and with picture not visible to listener condition, *p=0.28, p=0.12,* respectively. Means of *proportion of deictic gestures in demonstrative spatial words* for children and adults can be seen in table 4.11.

**Table 4.11**

*Mean (SD) of proportion of deictic gestures in demonstrative spatial words (%)*

| | No-picture condition | With-picture visible to listener condition | With-picture not visible to listener condition | Totals |
|---|---|---|---|---|
| Adult | 0(0) | 97.16(65.15) | 43.58(62.49) | 46.80(64.33) |
| Child | 21.74(37.70) | 84.17(93.28) | 51.74(61.10) | 54(72.23) |
| Totals | 10.23(27.33) | 90.67(78.34) | 46.64(60.03 | 50.04(67.41) |

Another 2x3 ANOVA was conducted on proportion of *iconic gestures in all words* as dependent variable; age and condition as independent variables. Analysis showed that this proportion was not significantly different across conditions, and between children and adults, F(2,47)=*1.58, 0.22,* and F(1,47)=1.23*, p=0.30,* respectively. Analysis also revealed that there is no significant interaction between age and condition, F(2,47)= 0.07*, p=0.94.* Means of the *proportion of iconic gestures* in all words for children and adults can be seen in table 4.12.

**Table 4.12**

*Mean (SD) of proportion of iconic gestures in all words (%)*

| | No-picture condition | With-picture visible to listener condition | With-picture not visible to listener condition | Totals |
|---|---|---|---|---|
| Adult | 25.25(22.95) | 22.95(6.34) | 19.20(13.57) | 22.35(9.61) |
| Child | 22.40(22.44) | 16.92(13.80) | 13.64(15.77) | 17.62(17.20) |
| Totals | 23.91(15.61) | 19.93(10.87) | 16.73(14.42) | 20.12(13.79) |

Next 2x3 ANOVA was conducted on *proportion of iconic gestures in combined spatial words* as dependent variable; age and condition as independent variables. Analysis showed that adults' proportion of iconic gestures in combined spatial words is significantly higher than children's, $F(1,47)=6.94$, $p=0.01$. This number was not significantly different across conditions, $F(2,47)=1.46$, $p=0.24$. Analysis also revealed that there is no significant interaction between age and condition, $F(2,47)= 0.04$, $p=0.96$. Means of the *proportion of iconic gestures in combined spatial words* for children and adults can be seen in table 4.13.

**Table 4.13**

*Mean (SD) of proportion of iconic gestures in combined spatial words (%)*

| | No-picture condition | With-picture visible to listener condition | With-picture not visible to listener condition | Totals |
|---|---|---|---|---|
| Adult | 42.20(11.82) | 35.21(11.54) | 32.96(23.83) | 36.65(16.92) |
| Child | 29.64(25) | 22.18(17.18) | 17.16(20.56) | 22.96(20.74) |
| Totals | 36.29(19.62) | 28.70(15.70) | 25.94(23.24) | 30.2(19.87) |

Finally for gesture analysis, 2x3 ANOVA was conducted on *proportion of iconic gestures in non-demonstrative spatial words* as dependent variable; age and condition as independent variables. Analysis showed that adults' proportion of iconic gestures in non-demonstrative spatial words is significantly higher than children's, $F(1,47)=4.68$, $p=0.04$. This number was not significantly different across conditions, $F(2,47)=1.25$, $p=0.30$. Analysis also revealed that there is no significant interaction between age and condition, $F(2,47)= 0.04$, $p=0.96$. Means of the *proportion of iconic gestures in non-demonstrative spatial words* for children and adults can be seen in table 4.14.

**Table 4.14**

*Mean (SD) of proportion of iconic gestures in non-demonstrative spatial words (%)*

| | No-picture condition | With-picture visible to listener condition | With-picture not visible to listener condition | Totals |
|---|---|---|---|---|
| Adult | 45.58(14.38) | 41.27(13.52) | 35.54(25.86) | 40.61(18.87) |
| Child | 33.32(28.5) | 29.37(24.12) | 19.87(23.30) | 27.59(24.95) |
| Totals | 39.81(22.33) | 35.32(19.93 | 25.87(25.37) | 34.47(22.70) |

To dig analyses about variables of iconic gestures (since the means in different measures looked different across conditions in line with our hypotheses) Independent Samples t test analysis were used separately for adults and children. 3 conditions were compared in the groups of 2 by using independent samples t test for the variables; number of iconic gestures, proportion of iconic gestures in all words, proportion of iconic gestures in combined spatial words and proportion of iconic gestures in non-demonstrative spatial words. In the explanation of t test results no picture condition will be referred as condition 1, with picture visible to listener condition will be referred as condition 2, with picture not visible to listener will be referred as condition 3.

Independent samples t test revealed one significant result which is for number of gestures in adults. According to this result, in adults, condition 1 and condition 2 is significantly different from each other in terms of number of gestures, $t(16)=3.624$, $p=0.002$ (2-tailed), meaning no-picture condition has higher number of iconic

gestures than with picture visible to listener condition. All results of t test analysis of the variables can be seen for adults and children in tables 4.15 and 4.16 respectively. Thus even though number of iconic gestures were used more often by adults in no picture than with picture visible to listener conditions, iconic gestures per spatial words did not differ across the groups-even with the t-tests.

**Table 4.15**

*t(df) values of the variables for adults in Independent t-test*

| Variable | Condition 1-2 | Condition 2-3 | Condition 1-3 |
|---|---|---|---|
| Number of iconic gestures | 3.624(16)* | -1.506(11.158) | 0.690(13.952) |
| Proportion of iconic gestures in all words | 0.761(16) | 0.782(13.035) | 1.258(13.216) |
| Proportion of iconic gestures in combined spatial words | 1.269(16) | 0.266(13.289) | 1.086(13.464) |
| Proportion of iconic gestures in non-demonstrative spatial words | 0.655(16) | 0.614(13.862) | 1.059(14.343) |

Note. Condition 1; No-picture condition, Condition 2; With picture visible to listener condition, Condition 3; With picture not visible to listener condition

*Significant at $p<0.05$ level(2 tailed)

**Table 4.16**

*t(df) values of the variables for children in Independent Samples t-test*

| Variable | Condition 1-2 | Condition 2-3 | Condition 1-3 |
|---|---|---|---|
| Number of iconic gestures | 1.061(15) | -0.187(11.187) | 0.754(14) |
| Proportion of iconic gestures in all words | 0.615(15) | 0.457(15) | 0.904(14) |
| Proportion of iconic gestures in combined spatial words | 0.725(15) | 0.549(15) | 1.091(14) |
| Proportion of iconic gestures in non-demonstrative spatial words | 0.309(15) | 0.822(15) | 1.032(14) |

Note. Condition 1; No-picture condition, Condition 2; With picture visible to listener condition, Condition 3; With picture not visible to listener condition

*Significant at $p<0.05$ level(2 tailed)

*Summary of gesture results*

Overall children and adults did not differ in the overall use of gestures per word in any of the conditions. However deictic gestures and iconic gestures responded differently to the conditions. As we have seen above with demonstrative words in the speech analyses, the condition in picture visible to addressee, both adults and children used more deictic gestures than the other conditions. There were differences in the use of iconic gestures per word across the conditions.

There were no differences in the use of deictic gestures per word, combined spatial words and demonstrative spatial words between adults and children. Thus both age groups interpreted this condition communicatively similar both in speech and gesture. They took advantage of the pictures being visible to the addressee and

described the vignette using more indexicals. However the use of deictic gestures did not respond differently to the with and without picture conditions suggesting that deictic gestures are not used for memory maintenance.

Unlike deictic gestures, iconic gestures per combined spatial word were found to be used more by adults than children. However their use did not differ across conditions statistically, not expected by the role of iconic gestures for memory maintenance. However there was a trend in the means suggesting more use of iconic gestures in no picture condition than with no picture conditions both for adults and children and this difference slightly being more for adults than children. Our results for in t-test analyses supports this trend, since in adults no-picture condition has higher number of iconic gestures than with picture visible to listener condition. However iconic gestures per spatial words did not differ between conditions.

# Chapter 5

## CONCLUSION and DISCUSSION

In this thesis I aimed to find out whether children and adults use gestures for memory maintenance in descriptions of spatial relations. Children and adults were asked to describe motion event movies after they watched the movies, either with memory aids with the pictures of the moving figures and the ground where the motion took place or without these aids. With picture conditions also varied between a case; where the listener could see the pictures with the speaker or not.

I found that the spatial language in the speech did not differ across conditions –in the with or without picture condition for adults or children. This provided a good basis for me to test the memory maintenance hypothesis by eliminating the possibility of lexical retrieval function of gestures. Knowing that the spatial content of speech is similar across conditions, if I had found amount of gestures is higher in one condition, then it would mean gesturing did not facilitate spatial speech. If lexical retrieval was the only function of gestures, in the condition in which amount of gesturing is highest, the amount of spatial speech should have been the highest, too. I found no difference in the spatial speech across conditions in my thesis. Therefore, If I had found differences in the amount of gesturing, that difference could have been attributed to different functions of gestures other than lexical retrieval.

In contrast to the literature that has shown that speakers use more iconic gestures in cases where they can not see what they describe- giving support for the role of gestures in memory maintenance –I have not found children or adults to use more iconic or deictic gestures when they describe the motion event they have seen without any memory aid. So the hypothesis that gestures aid memory maintenance is not supported in this study.

There can be different reasons for this null effect. The size of the sample for each group was small to reveal significant differences. Secondly the conditions with and without pictures were not so different from each other because I used motion movies rather than static pictures –as used in previous literature. Static pictures can be aid for the static spatial elements like figure or ground. Thus even in the with picture conditions there were no memory aids for the motion traces. If the vignettes were open in front of the speaker during descriptions then there could have been memory aids for all spatial elements. In the future the data can be re-analyzed in such a way that the memory effects can be investigated for the references made only for the figures or the ground objects in speech and gesture. In speech and gesture coding only static references can be coded and then all the analysis can be done with this data. That data should be analyzed to see whether the amount of iconic gestures differs across conditions or not.

The results of this study also revealed additional functions of gestures for adults and children. Both age groups used deictic gestures and demonstrative words in the condition where the listener can see the pictures more often than the other two conditions. Thus 5 year olds are aware of the use of both modalities to index

referents visible to both partners and they do not use gestures for objects when the listener cannot see them. So 5-year old children have similar understanding of the pragmatics of the communicative situation to adults. In the future this can be investigated to see whether it holds also for younger-i.e. 3 year old children.

Finally the study revealed differences in the use of spatial language and iconic gestures –independent of the conditions. Across the board children used more words with spatial content but adults used more iconic gestures per spatial word. Even though the reasons for these findings go beyond the scope of this study it can be interpreted as providing counter evidence for the lexical retrieval hypothesis. According to lexical retrieval hypothesis if amount of gestures was high in one condition, this would be because amount of spatial words is also higher in that condition (Morsella and Krauss, 2004; Krauss and Morsella, 2002). This is because according to lexical retrieval hypothesis gesturing is used to elicit spatial words (Morsella and Krauss, 2004; Krauss and Morsella, 2002).. However in our case children did not gesture more than adults –but it was the other way around. More research is needed to find out this inverse relation between spatial speech and use of iconic gestures in adults and children. It is possible that adults are more aware of the communicative function of their iconic gestures than children are. It is also possible that the complexity of the spatial representation and the descriptions as well as the semantics of the spatial language could be richer in adult speech compared to children. This would be in line with another function of gestures which is information packaging. According to this hypothesis speakers use gestures to represent and package complex information into units that can be chunked and represented by speech (Kita and Ozyurek, 2003). Our findings showed that adults

used more words than children. However children had higher proportion of spatial speech in their descriptions. Different types of utterances may make the content of adult speech more complex than children's speech. Adults may need to conceptualize more because of the complexity of their speech. That may be why they used gestures more than children. However in our study we did not directly measure the complexity of the spatial content to test Information Packaging Hypothesis. My statements are just suggestions about Information Packaging hypothesis to light a bulb for further studies.

Thus to conclude in the current study I did not find support for the memory maintenance function of gesture for spatial memory for adults or children. However more data and analyses could further test this claim. In addition I found evidence for other functions of gestures such as pointing gestures when the picture is visible to the listener has the same frequency for both adults and children. Finally adults might use gestures more than children since they have to describe more complex and richer representations suitable for speaking than children. Further analysis of the data can reveal whether this can explain the more frequent use of iconic gestures in adults than children even though they used less number of words with spatial content.

# APPENDICES

Figure 1 - Layout of the with-picture not visible to listener condition

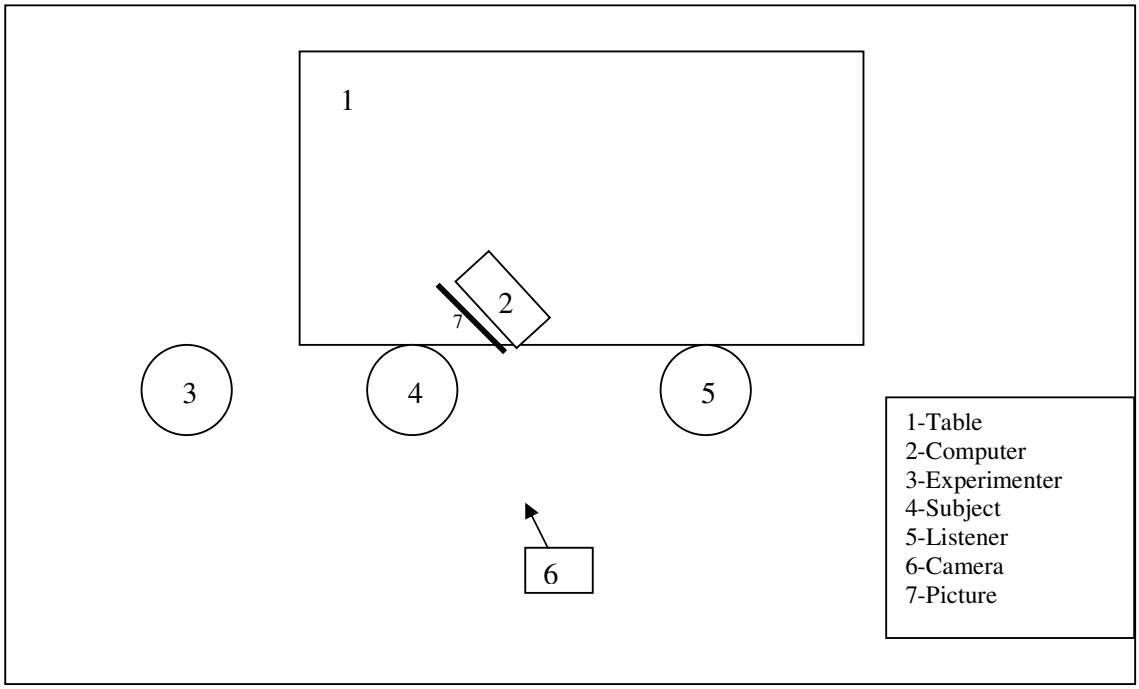



Figure 2- Layout of the with-picture visible to listener condition

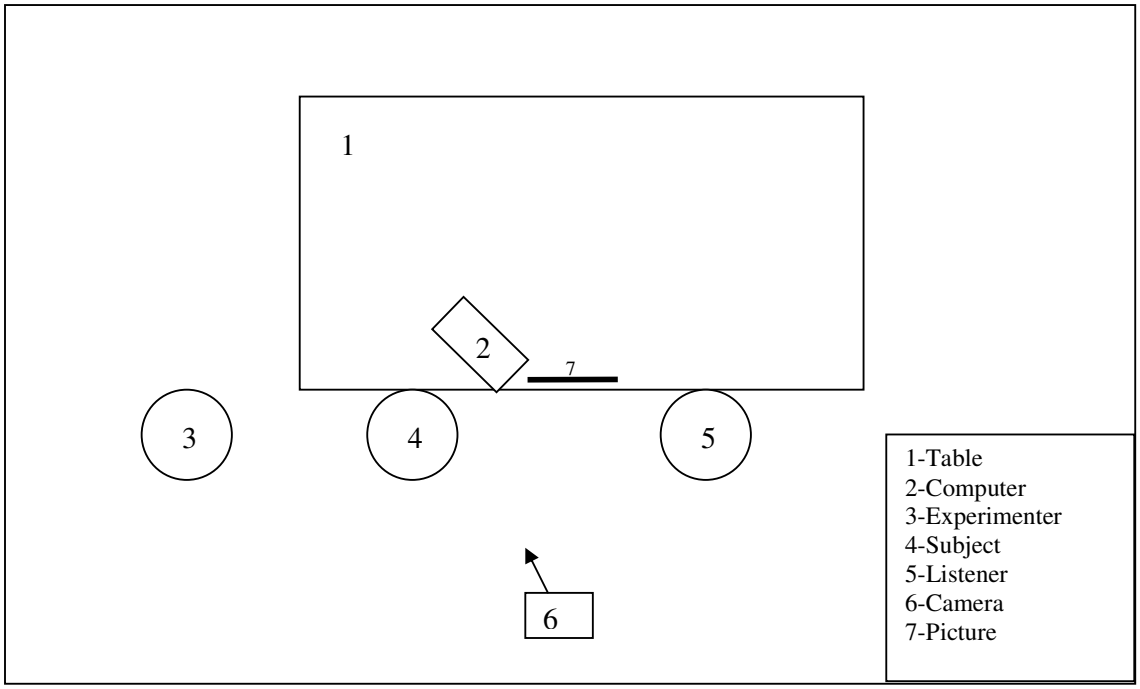


Figure 3- Layout of the no-picture condition

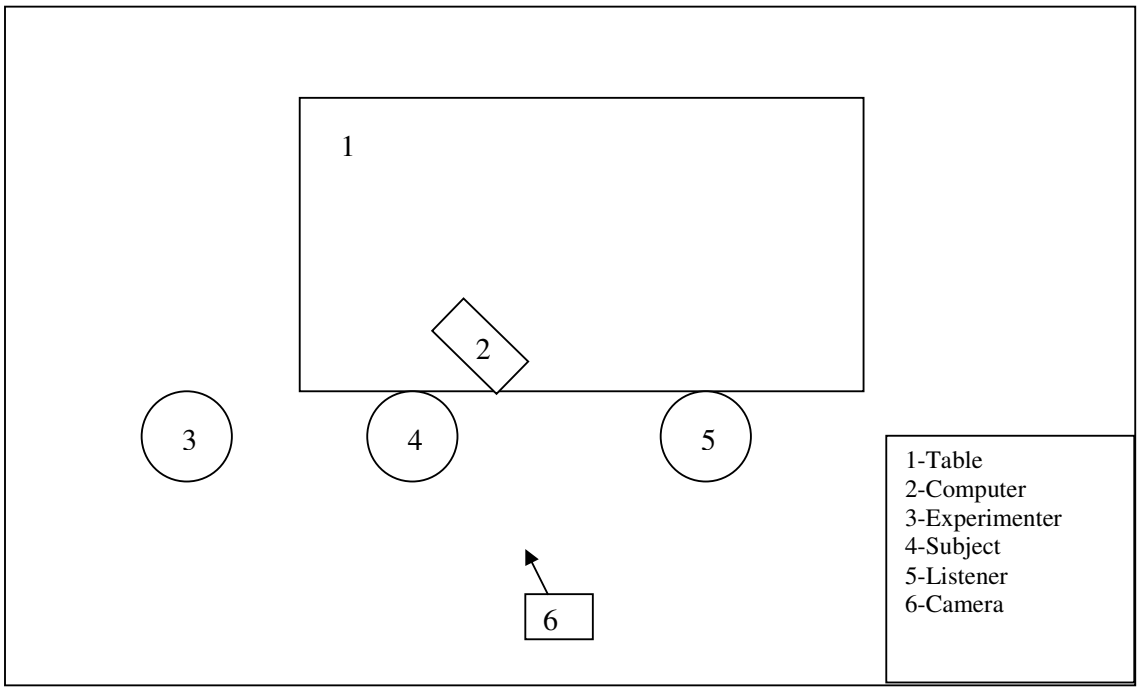


Figure 4 : Picture Depiction for vignette 1

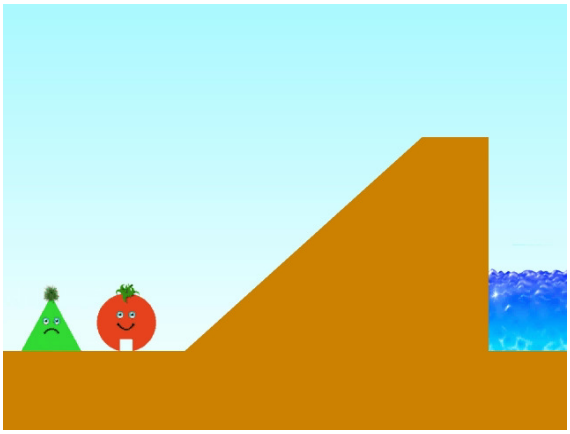


Figure 5 : Picture Depiction for vignette 2

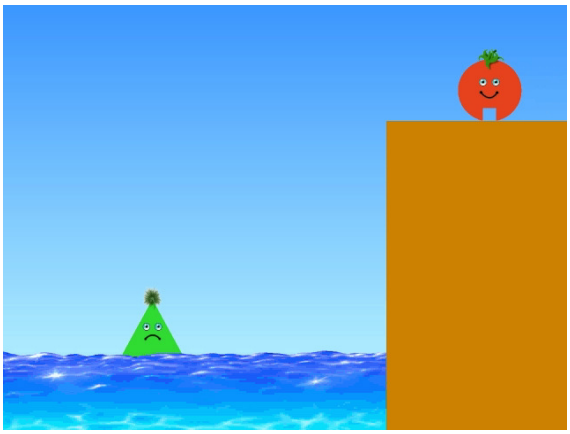


Figure 6 : Picture Depiction for vignette 3

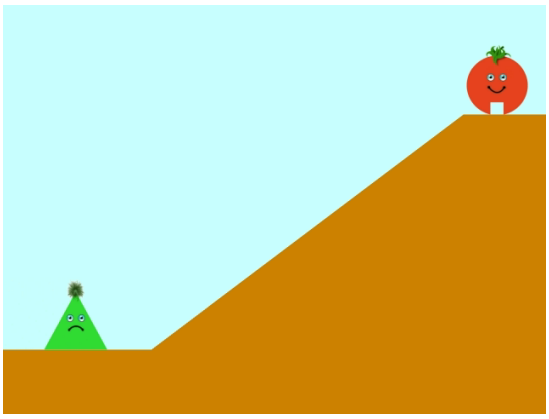


Figure 7 : Picture Depiction for vignette 4

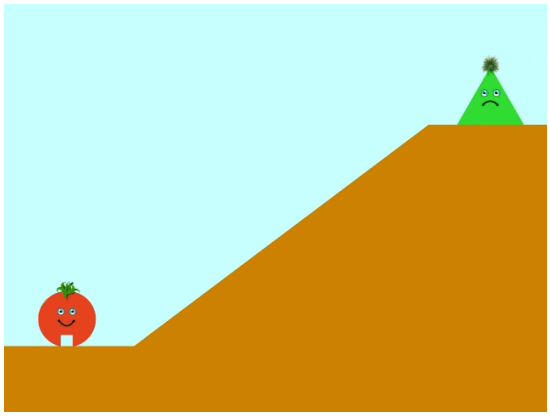


Figure 8 : Picture Depiction for vignette 5

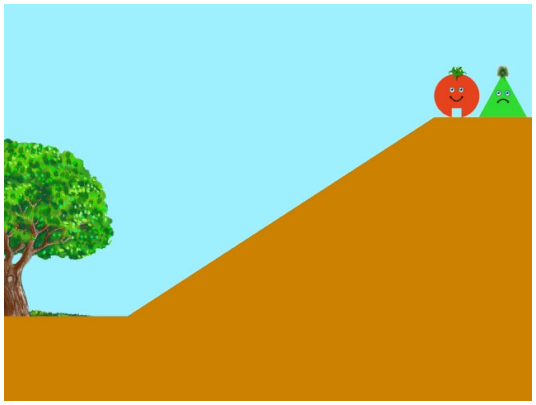


Figure 9 : Picture Depiction for vignette 6

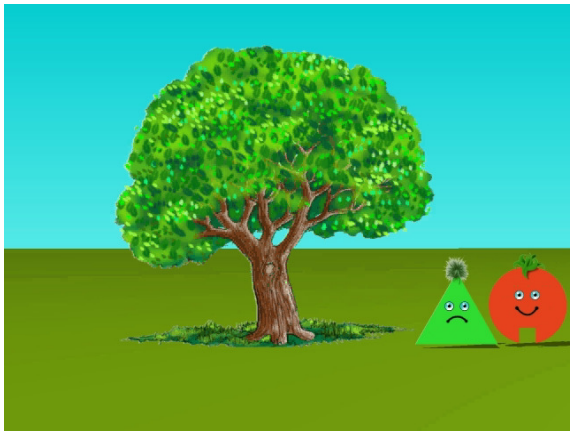


Figure 10 : Picture Depiction for vignette 7

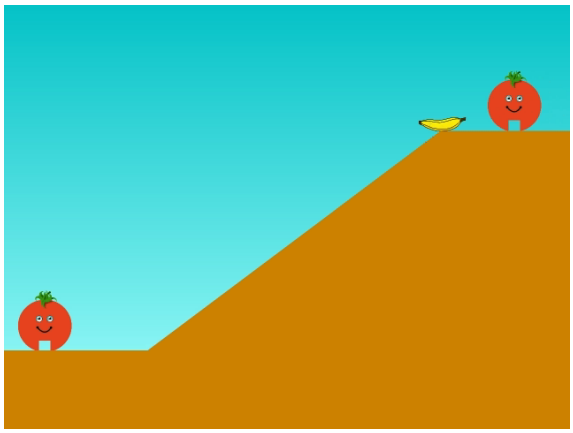


Figure 11 : Picture Depiction for vignette 8

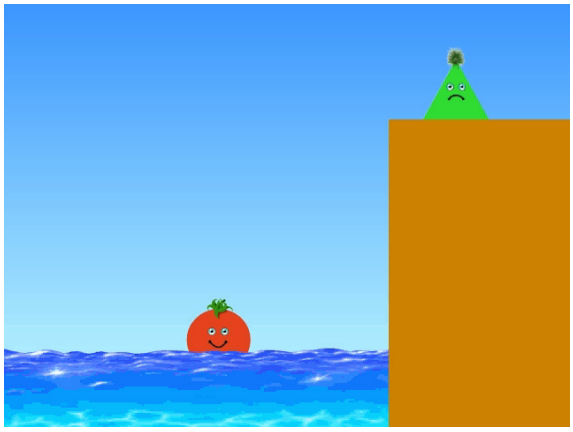


Figure 12 : Picture Depiction for vignette 9

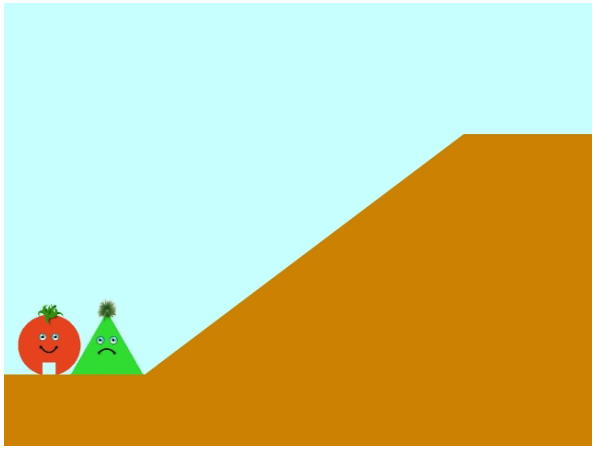
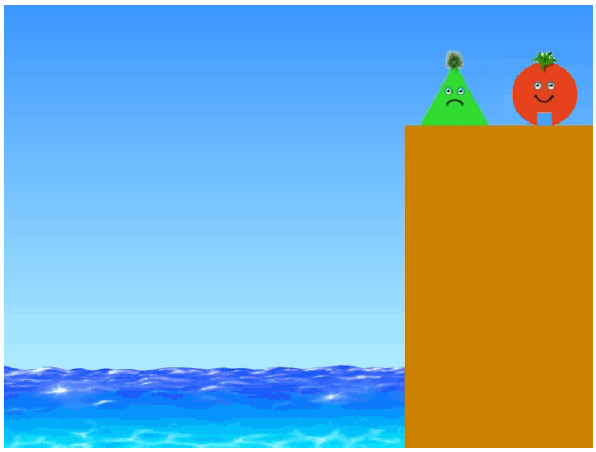


Figure 13 : Picture Depiction for vignette 10



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