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The influence of gestures and modal density on comprehension and memory

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Abstract

This thesis investigates the effect of gestures and modal density on comprehensibility and memory of action sequences. The following research questions are explored: “To what extent does the perception of gestures and multiple additional modes of communication influence comprehensibility of action sequences?”, and “To what extent does the perception of gestures and multiple additional modes of communication influence memory of action sequences?”. Previous research has mainly focussed on gestures as an additional mode of communication alongside speech output causing for better memory retention because they contribute to the communication of semantic information. However, this thesis will try to show that the increase in memory retention is caused by an increase in the amount of attention paid. Thus, an increase in modal density will cause for an increase in memory retention. The hypotheses are tested with an experiment consisting of two testing moments. Data collected using a question list is analysed by means of a one-way between groups ANOVA. Results show that comprehension is higher when gestures are used alongside speech, but that multiple additional modes obstruct comprehension, because they do not communicate semantic information. No significant impact of modal density on memory was found. Further research should be conducted with native speakers of English and a larger sample size in order to conclude anything with more certainty.

Keywords: modal density, gestures, comprehensibility, memory, perceiving, influence.

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1. Introduction

Human beings use more than just language to communicate. They communicate through multiple modes of communication such as language, gestures, pictures, and body movements. The research field concerned with this is that of multimodal studies. This field of research is concerned with how multiple modes of communication are used to communicate, convey meaning, and how they interact with each other (Norris, 2004). A considerable amount of research has been conducted investigating multimodal communication and primary areas of investigation have been: the influence of gestures on word learning and how gestures contribute to the communication of semantic information (Kelly, & Özyürek, & Maris, 2010; Beattie & Shovelton, 1999; Holler, & Shovelton, & Beattie, 2009; Tellier, 2008; McNeill, 1985; McNeill, 2005).

Gestures have been recognised as an important mode of communication because research has shown that gestures can assist in language learning, because they contribute additional semantic information alongside speech output (Kelly, & Özyürek, & Maris, 2010; Beattie & Shovelton, 1999; Holler, & Shovelton, & Beattie, 2009). An example of such a research is that by Tellier (2008). In this study an experiment was conducted examining the influence of gestures on memory and learning of lexemes in a second language. The results of the experiment have shown that when gestures, used as an additional mode of communication alongside speech output, are used they have a positive influence on the memorisation of lexical items in a second language. This would suggest that the reproduction of gestures and thus making use of multiple modes of communication significantly increases language learning and memory retention.

However, Lüke and Ritterfield (2014) found surprisingly that both iconic and arbitrary gestures have a positive influence on language learning and memory of lexical items. They

conducted an experiment with young children learning lexemes in a second language. They initially set out to test their hypothesis that the use of iconic gestures would show better support for memory than the use of arbitrary gestures. Their findings are surprising given that iconic gestures contribute semantic information of a word or utterance while arbitrary gestures do not. They should actually have the opposite effect as they contribute nothing to the semantic field (Lüke & Ritterfield, 2014).

One explanation for these unexpected results could be that arbitrary gestures attract the attention of the social actor and therefore cause for more attention paid. The increased attention motivated by input from multiple modes of communication might cause for better memory retention. Based on the idea of joint attention, this is that what a social actor uses in order to establish what another social actor is paying attention to, the use of gestures causes for an increase in the amount of attention paid. More attention paid by a social actor to an action causes for more traces to be left in memory and thus an increase in the amount that is comprehended and remembered (Tomasello, 2008, Underwood, 1976). The use of multiple modes of communication thus causes for an increase in the amount of attention paid and leaves more traces in memory.

However, if this is the case it should not be restricted to gestures, but multiple additional modes of communication such as posture, gaze, and head movement should also motivate increased attention and thus increase memory retention. These are modes of communication with their main function being grabbing attention from the listener. Previous research has mainly focussed on gestures because they contribute additional semantic information, but not yet on multiple additional modes of communication that increase the amount of attention paid. Previous research has also mainly focussed on the effect of gestures and multiple additional modes of communication when they are reproduced by the speaker. What has not yet been focussed on however, is the effect on comprehension and memory of

the perceiver.

This leads to the following research questions guiding this thesis: “To what extent does the perception of gestures and multiple additional modes of communication influence comprehensibility of action sequences?”, and “To what extent does the perception of gestures and multiple additional modes of communication influence memory of action sequences?”. The hypotheses are: “Comprehensibility of action sequences will improve significantly as modal density increases”, and “Memory of action sequences will improve significantly as modal density increases”.

The hypotheses are tested with an experiment consisting of two testing moments, a comprehension test and a memory test. The data collected through question lists is analysed by means of a one-way between groups ANOVA.

This thesis will first examine an extensive literature review on how and why gestures and modal density contribute to comprehension and memory. After the background information the setup of the study and the results of the experiments are explained in the methodology and the results section. The results are then explained in the discussion section and it is evaluated whether the hypotheses are confirmed or not. The discussion section will also propose suggestions for further research in the field. Lastly, the conclusion section provides a summary of the thesis and the research questions are answered.

2. Literature review

Gestures are movements of the body that are used by a social actor in order to convey meaning. They are connected to speech in such a way that they express the same idea as speech, but they do so in their own way and they express their own aspect of this idea. They are thus not redundant to speech (McNeill, 2005). Gestures provide listeners with semantic information and it has been shown that they improve comprehensibility and memory for word learning (McNeill, 1985; Beattie & Shovelton, 1999; Holler, & Shovelton, & Beattie, 2009). The use of several communicative modes causes for a social actor to make use of modal density. Modal density causes for joint attention from both speaker and listener and this accounts for better memory retention, because more attention is being paid. An increase in attention caused by modal density leads to an increase in memory retention as well.

2.1. Gestures and their connection to speech

As explained by Kendon (2004), a gesture is a visible action used as an utterance or as part of an utterance. Abner (2015) then adds some more to this definition by stating that “gestures are visible and diverse actions. They can include: illustrations of the size, shape, and location of objects, demonstrations of how to perform actions; depictions of abstract ideas and relationships” (Abner, 2015, p. 437). Gestures are thus, by this definition, movements that convey meaning. They are visible actions used with utterances in order to convey meaning. However, not all body movements can be classified as gestures. When defining gestures, one looks at the movement of hands and arms (Kendon, 1994). Other movements of the body, or non-verbal communication, such as head movement, gaze, and posture, are not gestures but are rather other modes of communication. What this entails will be examined later in this literature review.

Gestures are by all means used for several purposes. Kendon (1988) nicely places hand gestures along a continuum, called ‘Kendon’s continuum’ by McNeill (1992, p.120),

that shows four ways in which hand gestures are used.

1. Gesticulation (speech-synchronised gestures)
2. Language like gestures (linguistic indexing)
3. Emblems (rhetorical gestures)
4. Sign language

This continuum shows from one to four gestures replacing the role of speech. It does not show or explain the function of the gestures, but rather only describes the various ways in which gestures can or cannot be connected to speech output. The types of gestures that are relevant for this research are those that occur together with narrative discourse thus gesticulation or speech-synchronised gestures.

Four types of gestures have been shown to occur with narrative discourse (Cassel, McNeill & McCullough, 1999, p. 5-7):

1. Iconic gestures: These types of gestures depict by the form of the gesture some feature of the action or event being described. In this case the gesture corresponds directly with that what is being said in speech. They may specify the manner in which an action is carried out and can also specify the viewpoint from which the action is narrated.
2. Metaphoric gestures: With these types of gestures the concept being depicted has no physical form but still has representation in the narrative. They may specify that a new narration or new segment of a narration is beginning.
3. Deictic gestures: They indicate space and place, or locate in the physical space in front of the narrator, aspects of the story being narrated (pointing right and left). They can locate characters in space and make the relationship between them more apparent.
4. Beat gestures: These are small baton like movements that do not change in form with the content of the speech. They have a more pragmatic function. An example is the rhythmic beating of a hand to emphasise a part of the speech.

The present research will focus on iconic, metaphoric, and deictic gestures only. These three types of gestures will be focussed on because they have been found to contribute semantic information in communication alongside speech output, they contribute to meaning. (Holler & Shovelton & Beattie, 2009).

Besides the fact that gestures convey meaning, arguments can be found that suggest gestures to be connected to speech. They are not just additional non-verbal movements. Gestures are co-expressive to speech because they express the same underlying idea, but they do so in their own way. They express a different aspect of an idea and therefore contribute to meaning (McNeill, 2005). Two features of gestures that can be identified are that they carry meaning and that they are co-expressive with speech, they are co-expressive but not redundant (McNeill, 2005, p. 23). This means that gestures and speech express the same underlying idea, but they express it in their own way and they both express their own aspect of this idea. McNeill (1992, p.13) provides a well know example that shows that gestures can provide semantic information related to an underlying idea that is not expressed in speech. In the example, a speaker describes an event from a cartoon in which one character is chasing another character with an umbrella. The event is described by the speaker with the words: ‘she chases him out again’. What the speaker does not say, however, is that the chasing is done with an umbrella. This part of the idea is only expressed with the iconic gesture of grabbing an umbrella and swinging it through the air. This is a clear example that shows that a recipient needs to understand both speech output and gestures in order to fully understand what is being communicated.

Not only are gestures co-expressive to speech, they are also synchronic. This means that they occur at the same moment of speaking. When this occurs the mind is doing the same thing in two ways, but is not doing two separate things. McNeill claims that “As long as speech and gesture share meaning; they comprise a virtually unbreakable psycholinguistic

unit.” (McNeill, 2005, p. 24). He then provides proof for this statement by introducing the following five claims about gestures and speech:

1. Delayed auditory feedback does not interrupt speech-gesture synchrony.
2. Gesture inoculates against stuttering.
3. Congenitally blind make gestures to other blind.
4. In memory gesture exchanges information with speech.
5. Gesture number and gesture complexity vary with cognitive fluency.

These show that gestures and speech are indeed linked and that they form a psycholinguistic unit. If this connection would not have been in place, the congenitally blind, for instance, would have no reason to gestures to other blind, because there is no communicative purpose. The fact that they do use gestures in this situation shows that there is a connection to speech.

Bavelas (1994) confirms McNeill’s claim that gestures are connected to speech by stating that they are connected in two senses. The first is that they contribute to meaning in the same way as words and phrases do. Gestures can be seen as ‘manual symbols’ (McNeill, 1985, p. 351) in the same way as words can be seen as auditory symbols. They both convey meaning. The second sense in which Bavelas claims that gestures are connected to speech is that similar to lexical items their meaning depends upon the context or the whole of which they are a part of (Bavelas, 1994). She thus compares gestures to speech output and states that they share some characteristics. They ultimately share the same goal; convey meaning and communicate. She treats gestures at a level of meaning instead of at a level of movement.

Another study by Holler and Bavelas (2017) investigated how common ground can influence gestures. Multiple research has depicted the influence of common ground as a purely verbal phenomenon. Holler and Bavelas, however, have reviewed this research and established that common ground also influences the use of gesticulation. ‘Common ground’ is defined by Holler and Bavelas (2017, p. 214) as “The knowledge, beliefs, and assumptions

that interlocutors share, combined with their mutual awareness that they share this particular ground”. Previous research has already found that common ground influences verbal communication to such an extent that the amount of words used decreases significantly (Tomasello, 2008). Not only does the amount of words used decrease, words are also more poorly articulated. This effect is paralleled in the use of gestures. Gestures tend to be more poorly articulated and the word/gestures ratio did not change. What these findings show is that common ground effects both speech and gestures. The fact that both speech and gesture are influenced and that gestures get more poorly articulated in cases where words are as well, shows that speech and gestures are connected. When this connection would not have been in place, the decrease in articulation of either verbal communication or gesticulation would not influence the other.

Several explanations can be found why we gesture and the present research is interested in why they are informative for hearers. Gestures are naturally attended to by listeners, they contribute semantic information to speech output and have been shown to improve comprehensibility and support word learning. In order to test whether listeners attend to gestures because they convey semantic information has been examined in a study by Lüke and Ritterfield. They examined the influence of iconic and arbitrary gestures on novel word learning in children (Lüke & Ritterfield, 2014). Their experiment consisted of participants having to learn words either with iconic gestures, arbitrary gestures, or no gestures. They have found that little to no difference can be seen between the use of iconic and arbitrary gestures and their effect on memory. Both increased memory of novel words significantly. This was an unexpected finding because they hypothesised that iconic gestures would contribute more to memory compared to arbitrary gestures, because iconic gestures contribute to the communication of semantic information. The surprising finding that arbitrary gestures contribute to word learning can be explained in three ways. The first is the Ceiling effect. In

their study Lüke and Ritterfield only made use of nine words that the participants had to learn. Given this relatively low number, this might have influenced the results. The second is the increased attention that is caused by the use of gestures in general (Underwood, 1976). More attention paid causes for better memory retention, this will be examined further in the next section of this literature review. The third is that of modal density. This taps into the idea of more attention paid but takes it one step further. Modal density means that a social actor makes use of more than one communicative mode. This leaves more traces in memory and would cause for the participants to remember the words with gestures better, regardless of the gestures being iconic or arbitrary.

The influence of gestures on comprehensibility becomes more apparent when the integrated-systems hypothesis by Kelly, Özyürek, and Maris (2010) is taken into consideration. This hypothesis explains two ways in which gesture and speech are integrated in language comprehension, namely mutual and obligatory interactions (Kelly, Özyürek & Maris, 2010, p. 260). The mutual and obligatory interactions in speech and gesture mean that they influence each other. Speech influences gestures and gestures influence speech. “The two modalities bidirectional interact during language production.” (Kelly, Özyürek & Maris, 2010, p. 260). It is also argued that this interaction is so strong and important that under many circumstances it is essential for speech and gestures to be coupled. Meaning that when a gesture is produced it often requires speech as well, and vice versa. Based on these claims in the production of gestures and speech they introduced the integrated-systems hypothesis. This hypothesis posits that “gesture and speech mutually and obligatorily interact with one another to enhance language comprehension.” (Kelly, Özyürek & Maris, 2010, p. 261). They thus argue that gestures contribute to comprehension because they interact with speech and because they are obligatorily connected to speech. When one of the two is missing comprehension is disrupted.

A study by Beattie and Shovelton (1999) tested McNeill's theory (1985) that gestures that accompany speech convey critical information in communication and therefore contribute to comprehensibility. They conducted an experiment with two groups of participants. The first group got to see a clip depicting aspects of a cartoon story and the second group only got to listen to the audio of the clip. They discovered that when respondents could see the gestures as well as hear the speech they received significantly more information about the cartoon than those who only got to hear the speech. This would confirm the idea that gestures are informative for hearers and that they contribute crucial semantic information in addition to speech.

Another study by Holler, Shovelton, and Beattie (2009) confirms that iconic hand gestures contribute to the communication of semantic information. Most previous research focussed on the influence of gestures when shown in a video. However, Holler, Shovelton, and Beattie claim that gestures might be exaggerated when shown in a video and a participant might focus more on the visual representation when watching a video stimulus. They conducted an experiment with four conditions: speech with gestures in a face-to-face context, speech without gestures in a face-to-face context, speech with gestures in a video context, speech without gestures in a video context. The results show that both conditions with gestures were understood significantly better than the condition without gestures. Another finding that was significant was that the face-to-face conditions were understood significantly better compared to the video conditions as well. These findings confirm the claim that iconic gestures contribute to the communication of semantic information. This also suggests that gestures contribute to comprehensibility of action sequences, because more semantic information is communicated and thus more is expected to be understood.

On the other hand, a study by McNeill, Alibali, and Evans (2000) was conducted in order to examine the influence of gestures on comprehension of spoken language. They

conducted an experiment with young children and they compared the influence of gestures alongside speech and no gestures used at all. They hypothesised that gestures would only influence comprehension when the message conveyed in the speech output was a complex one. They based this hypothesis on the assumption that “gestures provide external support, in the form of a redundant message, for the meanings expressed in speech” (McNeill, & Alibali, & Evans, 2000, p. 133). However, this assumption is incorrect referring back to the claim by McNeill mentioned above that gestures express their own aspect of an idea and are therefore not redundant. Gestures can only support comprehension when the information in the speech output is understood to some extent by the listener. What McNeill, Alibali, and Evans (2002) actually examined was whether gestures convey meaning in the first place, not how they support comprehension, but if they are comprehensible to begin with. When speech output is not comprehensible in the first place, a social actor will probably turn to the gestures and will interpret the semantic information conveyed in the gestures alone. This proves that gestures convey semantic information and are therefore not redundant.

2.2. Modal density

Besides gestures, there are other forms of non-verbal communication. Other communicative modes, such as gaze, posture, and head-movement, often provide semantic or pragmatic information alongside speech output. Communicative modes are “systems of representation or semiotic systems with rules and regularities attached to them” (Norris, 2009, p. 79). They are that what a social actor uses in order to construct a higher-level action. A communicative mode is something that is used to create and convey meaning and can also be used for focussing attention. When a speaker makes use of more communicative modes this can be called ‘modal density’. Modal density refers to the intensity and the way that several modes are intertwined through which a higher-level action is constructed (Norris, 2004, p. 15). Lower-level actions construct a higher-level action. A higher-level is constructed by the

influence that several communicative modes (lower-level actions) have on each other. The intensity of modal density and the different modes may vary and is dependent upon situation (Norris, 2004, p. 15).

Other forms of communicative modes besides spoken and written language and gestures are for instance music, sound effects, and pictures (Duncum, 2004). Besides these communicative modes others can be found with their main function being grabbing attention from a listener. The present research will focus on these communicative modes as well as on gestures and spoken language. The multiple additional modes of communication that are used in this study are: change of posture, gaze, and head movement. The influence of these multiple additional modes of communication on memory will be examined in more depth in the next section.

Modal density, as Norris posits, also gives insight into the locus of a social actor's attention during interaction (Norris, 2004). When a gesture is used that expresses the same idea as speech, modal density is used and this would cause the attention of a social actor to be pointed to both communicative modes. This would cause for an increase in the amount of attention paid, causing for better memory retention (Underwood, 1976).

When a social actor performs a higher-level action they pay attention to this action. The higher the modal density that a social actor utilized in order to construct that higher-level action, the more attention is being paid to the action. Making use of multimodality also leaves more traces in memory. This can be referred to as multimodal storage in memory (Tellier, 2008). Multimodality thus influences memory by leaving more traces in memory. Another argument that supports the claim that modal density is beneficial for memory retention is that of Clark and Paivio's Dual Coding Theory (1991). This suggests that the presence of both verbal and non-verbal modalities improve learning and memory. Dual coding theory comes from the idea that imagery can function as a memory aid. The emphasis on memory evolved

into the use of imagery for helping to acquire knowledge. The acquisition of knowledge would be easier with this memory aid in place. The effect on memory can be explained by verbal and non-verbal modes leaving more traces in memory. Participants in a study by Clark and Paivio (1991) were exposed to a free recall experiment. The participants who got to make use of both verbal and non-verbal modes recalled significantly more than the participants who only got to employ one mode. This confirms Tellier's claim that the use of multiple communicative modes leaves more traces in memory.

When a speaker makes use of modal density not only does the speaker himself pay more attention, but the perceiver does so as well. This can be referred to as joint attention (Tomasello, 1992). Joint attention is what underlies a social actor's ability to understand the ways others are using particular pieces of language (Tomasello, 1992, p.67). The influence of the amount of attention paid on memory will also be made more apparent in the next section.

2.3. Influence of attention on learning and memory

Looking further into the benefits that a listener might have from perceiving a speaker making use of modal density, the amount of attention paid plays a big role. It can be said that more attention is paid by both the speaker and the perceiver because of the use of modal density (Duncum, 2004). Especially the use of gestures and multiple additional modes of communication, which are more visual communicative modes, are expected to increase the amount of attention paid by the listener. When more attention is paid by the listener to an action, story, or simply to the speaker more will be remembered. A book by Geoffrey Underwood called *Attention and Memory* (1976) includes a chapter specifically about the relationship between attention and memory. It describes that when more attention is being paid more will be remembered. Perception and memory were previously seen as serial processes, but Sperling (1963) has shown that perception and memory are actually interrelated. Sperling developed a technique to test iconic memory. Iconic memory is the

visual sensory memory which only lasts for a very brief period of time. Although it only lasts for a moment, iconic memory is connected to long-term memory. This fits in with Clark and Paivio's study that the combination of both visual and non-visual input causes for better memory retention. More traces are left in memory causing for better memory retention. Thus, when a hearer is paying more attention to a speaker because that speaker is making use of more communicative modes and thus modal density more will be remembered by the listener. The combination of more attention being paid by the listener which leads to better memory retention and the use of more communicative modes leading to multimodal storage in memory, should significantly improve the listener's memory.

A study by Schegloff (1984) has shown that gestures tend to precede the words that lexically corresponded them and that the gesture could therefore signal the introduction of the new meaning into the conversational stream before it surfaced in speech (Schegloff, 1984, p. 273). In this way, gestures are used as a sort of context. The present research examines the effect of gestures on comprehension and memory and if gestures are considered as context it will be likely that they will indeed improve memory. A study conducted in 1971 by Dooling and Lachman has shown that context provided with a story will significantly improve comprehensibility and memory of that story. An experiment with two different groups of participants was conducted. The first group got to read a story without any context provided and the second group got to read a story with context provided before reading in the form of a title provided with the story. Afterwards, both groups were asked to score the story in terms of comprehensibility, 1 being very hard and 10 being very easy. Both groups were also tested on their memory of the story they had read a few minutes before. The participants were asked to write down as much as they remembered of the story they had read. For both the comprehensibility and the memory task the second group, with context provided before reading, scored significantly higher. These results would suggest that context indeed provides

support for both comprehension and memory retention. Thus the use of gestures will improve memory as well, because they can be classified as a sort of context.

Given joint attention and its contribution to language learning the following hypothesis is plausible. Social actors are able to naturally determine where the attention of another social actor lies through the perception of modal density. This perception of productive attention will therefore motivate joint attention to some propositional content. Due to the increase in attention and awareness of the perceiver it is likely that the propositional content which exemplifies modally dense lower-level actions through multiple simultaneous modes of communication, it seems plausible that modally dense propositions will be:

a) more clearly understood due to increased perceptual attention and b) the propositional content will be better retained in memory. This would account for arbitrary non-semantically associated gestures contributing to word learning given that it is not about semantic richness in the proposition, but about increased perceptual attention which is motivated by modal density.

2.4 Previous research

Previous research has mainly focussed on the effect gestures have on memory. They all focussed on gestures because they provide additional semantic information alongside speech output. However, this thesis argues that the increase in memory is mainly caused by an increase in the amount of attention paid because of the use of modal density. What has not yet been examined is whether an increase in modal density, making use of more modes of communication in addition to gestures, causes for more attention paid and thus an increase in comprehension and memory.

What previous research has not yet focused on either, is the effects that gestures and modal density have on perception of them alone. Most previous research has focussed on the effect of gestures when a speaker uses them to reproduce certain words. General

comprehension and memory has not yet been focused on.

Previous research has focussed on how arbitrary and iconic gestures might influence word learning and if a difference can be seen between the use of these two types of gestures regarding word learning. An example of such a research is that by Luke and Ritterfeld (2014) who have examined the influence of iconic and arbitrary gestures on novel word learning in children with and without specific language impairment (SLI). In their experiment they conducted two separate tests, but the present research is only interested in the first test. The first test included children without SLI who were presented with nine cartoon characters each representing novel words they had to learn. Some characters were presented with iconic gestures, some with arbitrary gestures, and some without any gestures at all.

The results of this first test have shown that the children reached higher receptive performance in novel word learning when the words got presented with iconic or arbitrary gestures compared to words without gestures. The most significant findings of this test are that no difference can be found between the words with iconic gestures and those with arbitrary gestures for word learning. They then concluded from these results that there is no significant difference between the use of iconic and arbitrary gestures for novel word learning, but they have not provided a reason for this. Their hypothesis is also not confirmed by these results because they hypothesised that words with iconic gestures would be learned better than words with arbitrary gestures, because iconic gestures contribute to the communication of semantic information whereas arbitrary gestures do not. They do briefly mention that it is possible that the use of gestures in general might have enhanced the interest of the child compared to the use of no gestures, but they do not mention modal density or that more attention paid by the children could increase memory. The present research will thus try to show that it is because of modal density that more attention is paid and thus more will be remembered and not because of the difference between the types of gestures used.

Previous research has also focussed on the effect that gestures have on vocabulary learning. They all focussed on specific lexical items but not on memory and comprehensibility in general. An example is a study by Tellier (2008). She has examined the effect of gestures on vocabulary learning in young French children learning a second language (English). The children were divided into two groups. One group had to learn five words with accompanying gestures and the second group had to learn five words with pictures. The group with gestures was told that they also had to reproduce the gestures. The results have shown that the reproduction of gestures significantly improved memory of the second language lexical items. These findings are consistent with the idea of modal density and multimodal storage in memory and the conclusion section mentions this as well, unlike the study mentioned above by Lüke and Ritterfield. However, both Tellier's and Lüke and Ritterfield's research only focuses on memory of specific lexical items when the participants were told they had to memorise the words. Because the participants were aware of the fact that they were being tested on memory, they might have paid more attention to the visual and the auditory input in the first place. This way the study does not focus on comprehension or memory in general. Another aspect that might have influenced the results in Tellier's study is the use of cartoon characters in the video stimulus. Cartoon characters usually exaggerate movements they make and express what they say with their hands and body. This exaggeration of the communicative modes might have influenced the results. The present research on the other hand examines whether perceiving gestures with action sequences influences comprehensibility and memory in general even when the participants are unaware of the fact that they are being tested on their memory beforehand. This study will also make use of more natural, less exaggerated, gestures.

Other studies, including the study by Tellier mentioned above, have also focussed on how gestures influence memory when a speaker makes use of gestures himself when telling or

re-telling a story. What has not yet been focussed on, however, is the influence gestures have on memory when they are simply perceived, thus the benefits of gestures and modal density for the listener/hearer. Previous research has mainly conducted experiments where participants were shown a story or they had to learn words and afterwards they had to reproduce the story or the words. Whilst retelling the story the participants could make use of the gestures for their own memory. An example is a study by Cassel, McNeill, and McCullough (1999) who have examined the influence of gestures on memory. The participants had to watch a video and were asked to reproduce what they had seen afterwards. They could make use of gestures with their reproduction and thus their study mainly shows the effect of the use of gestures on memory instead of the perception of gestures.

The present research, however, examines the influence of gestures on the listeners' comprehensibility and memory alone without them being able to reproduce the gestures. Previous research has thus mainly focussed on the use of gestures on memory but not so much on the perception of gestures on comprehensibility and memory alone. Considering modal density and the effect that the amount of attention paid can have on comprehension and memory it is useful to examine the effect of the perception of gestures alone. This could reveal more about the multimodal storage in memory and whether perception of gestures has the same or a different effect on comprehension and memory as the reproduction of gestures. That is what this research can add to the field alongside the aim of this thesis trying to show that an increase in modal density causes for better memory retention.

3. Methodology:

This thesis explored whether gestures and multiple additional modes of communication improve comprehensibility and memory of action sequences. The hypothesis leading the investigation was that gestures and multiple additional modes of communication will significantly improve comprehensibility and memory of action sequences. In order to test the hypothesis, 29 participants were asked to watch a video stimulus and afterwards they had to answer 15 content based questions related to the story told in the video. The watching of the video and answering of the question list was the comprehension test. The participants were then asked to answer the questions again three days later in an online environment. The answering of the question list for the second time was the memory test in which 18 students participated. A one-way between groups ANOVA was conducted for both tests in order to establish whether a significant difference was found between the three groups with the following conditions: no gestures, gestures only, and multiple additional modes of communication.

3.1 Participants:

The participants in this study were all first-year students of English language and culture at Radboud University. A total of 29 students participated in the experiment and completed the comprehension test. During the second test, the memory test, only 18 students participated. Unfortunately, not all students completed the memory test that was distributed online, causing for less participants in the memory test. The selection criteria for the participants were that they should be in their first year of English language and culture at Radboud University and that English is their second language. A minimum proficiency level of B2 was a key demographic variable so that the participants' proficiency level did not interfere with the comprehensibility of the video, which contained English of a lower level. If participants with a lower level of English would have participated in this experiment it might

have been harder for them to understand the story in the first place which could result in a negative influence on the comprehensibility. At the end of the first year of studying English language and culture at Radboud University the students should have acquired a proficiency level somewhere between B2 and C1 of the Common European Framework of Reference for Languages (CEFR). The CEFR is a framework that provides descriptions of language learners' proficiency at six different reference levels (Council of Europe, 2001). What the levels B2 and C1 entail is described in Table 1.

Table 1. Common Reference Levels according to the CEFR: levels B2 and C1. (Council of Europe, 2001, p. 25).

C1	Can understand a wide range of demanding, longer texts, and recognise implicit meaning. Can express him/herself fluently and spontaneously without much obvious searching for expressions. Can use language flexibly and effectively for social, academic and professional purposes. Can produce clear, well-structured, detailed text on complex subjects, showing controlled use of organisational patterns, connectors and cohesive devices.
B2	Can understand the main ideas of complex text on both concrete and abstract topics, including technical discussions in his/her field of specialisation. Can interact with a degree of fluency and spontaneity that makes regular interaction with native speakers quite possible without strain for either party. Can produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options.

3.2 Materials:

The materials used in this experiment consisted of two main parts: a video stimulus and a comprehension test involving short content based questions about the narrative. The video stimulus involved one actor who narrated a story involving Tweety and Sylvester. The narrative told by the actor was based on three action sequences from the show 'Tweety and Sylvester'. This is quite an old cartoon show with similar episode plots for each episode and this therefore minimizes the chance of the participants remembering one action sequences better than the other.

An actor performed the narration which was audio-video recorded. The narrative described exactly what was shown in the actual episodes of the show and this was re-enacted by the actor re-telling the story. Since the story contained rather easy English, the chance of the participants not understanding the story was eliminated, because all the participants had a relatively high level of English.

A total of 15 propositions in the narrative were produced by the actor either through spoken language alone, spoken language and gestures, or spoken language and multiple additional modes of communication. This created 5 propositions for each group. First, the narrative was written out and later five lines for each group were carefully selected to make sure the use of gesticulation was divided equally throughout the story. The re-enactment was thus designed in such a way that every action sequence of the video stimulus contained the same amount of gesticulation. The written out narrative can be found in Appendix 1.

The difference between gestures only and multiple additional modes of communication might not be very apparent and therefore an example from the narrative is required. The following two sentences were included in the narrative. The first was acted out

with gestures only and the second was acted out with gestures and multiple additional modes of communication.

1. Sylvester tries to cut down the pole
2. He just flies away.

For the first sentence the actor produced an iconic gesture depicting the cutting with the hand and arm.



Picture 1: Screenshot video gestures

The second sentence however, was acted out by the actor by making use of the entire body. The actor makes use of an iconic gestures depicting flying with hands and arms and also changes posture and looks in a different direction.



Picture 2: Screenshot video gestures +

The sentences with no gestures used only included speech. An example of such a sentence from the narrative is: “Tweety is hiding in a bucket full of tennis balls.”

Referring back to the theory mentioned in the literature review the gestures and body movements used by the actor have been selected carefully. The gestures only condition only includes gestures acted out with hands and arms because this is the definition of gestures by Kendon (1994). The other additional modes of communication used by the actor in the condition gestures and additional modes of communication have been selected carefully as well because they had to serve the function of grabbing the attention from the listener. Gaze, posture, and head movement are the additional modes of communication used by the actor because it has been shown that they attract the attention from the listener (Norris, 2004). The gestures used by the actor were all thought of beforehand. The actor was told to make use of the additional modes of communication mentioned before but to make it seem as natural as possible. They were not directed beforehand.

The three conditions were divided equally throughout the story. The answer sheet consisted of 15 questions with five questions for each group; no gestures, gestures only, and gestures and multiple additional modes of communication. These questions were all related to the 15 lines marked in the story and follow the same order as the sentences in the narrative (first question relates to first marked sentence). The question list can be found in Appendix 2.

3.3 Design of study:

The experiment was conducted in three separate classrooms. The first classroom consisted of 8 students, the second also consisted of 8 students, and the third consisted of 13 students. The experiment consisted of two separate tests and two testing moments. The first test included the watching of the re-enacted video and the answering of the first list of questions. This was the comprehensibility task. The second test included the answering of the

same list of questions in an online environment three days later, without getting to see the video stimulus again. This was the memory test.

For both tests the dependent variable was the number of answers that had been answered correctly by the participants. The independent variable was the use of gesticulations. This was divided into three groups:

1. Speech with gestures and multiple additional modes of communication
2. Speech with gestures
3. Speech without gestures

A one-way between groups ANOVA was conducted in SPSS for both tests. The ANOVA, however, was not conducted as it usually would have been, which is per participant. For this research every participant was tested on the three groups separately. So for the first test 29 participants were tested on all three groups of types of utterances creating a population of 87 participants in total. For the second test a total number of 18 students participated creating a population of 54 participants in total. By conducting the ANOVA in this manner, instead of with three actual independent sets with different participants, independent differences between participants did not influence the results. This way the difference between the three groups of gesticulation was the only factor that influenced the results, because the same participants were used. When each group would have been tested with different participants the results might have been influenced by personal differences. e.g. differences in memory and proficiency level. Another reason why the use of the same participants was useful for this research is because it was interesting to find out whether a difference could be seen between the use of gestures with multiple additional modes of communication, gestures alone, and no gestures used. This would become more evident when the same participants were used for these three groups. Cassel, McCullough, and McNeill (1999) apply a similar approach in their experiment i.e., they also made use of the same

participants for each condition. This way it would tell more about the effect of gestures on understanding of a narration (Cassel, & McCullough, & McNeill, 1999, p.15). What Cassel, McCullough, and McNeill set out to find out was whether a mismatch between gestures and speech influences comprehensibility. Subjects were shown a re-enactment of a cartoon story and later had to reproduce the story. They were shown a segment where speech and gestures matched and a segment where speech and gestures mismatched. "If gesture has no effect on understanding of a narration, the subjects who saw the two versions of the video (which contained exactly equal speech) should produce equally accurate-to-speech retellings." (Cassel, & McCullough, & McNeill, 1999, p.15) When different subjects were used for both conditions this could not have been tested and the same goes for this experiment.

3.4 Procedure:

At the beginning of the experiment the participants were given instructions about the experiment and the assignment. The video containing the story and the different action sequences was shown after this. After having seen the video the participants received a list with questions they had to answer to the best of their ability. After the participants were done answering the questions the question lists were collected. Three days after the initial exposure to the video and the first question list the participants were given another test which was the same as the comprehension test. However, they did not get to see the video again, but were only asked to complete the content test again.

3.5 Data analysis:

The data of the experiment was analysed by means of a one-way between groups ANOVA. This design showed whether a significant difference could be seen in the amount of correct answers between the three groups; gestures and multiple additional modes of communication, gestures only, and no gestures.

A one-way between groups ANOVA is based on the following assumptions that needed to be checked before conducting the ANOVA (Field, 2009):

- 1) Assumption of independence. The data is randomly and independently sampled.
- 2) Scale of measurement. The dependent variable must be on a continuous scale.
- 3) The assumption of normality. The dependent variable is normally distributed within the groups.
- 4) The assumption of homogeneity of variance.

Assumptions 1 and 2 were checked and assumed for both tests and assumptions 3 and 4 were checked and explained in more depth in the results section.

4. Results

This results section shows the results found in both the comprehensibility and the memory tests. A one-way between groups ANOVA was conducted for both tests to compare the effect of modal density on the number of correct answers.

4.1 Results comprehensibility test

As mentioned in the methodology section, prior to conducting the ANOVA the assumptions of normality and homogeneity of variance were evaluated.

The assumption of normality was checked and determined to be satisfied. Based on the results shown in Table 2, which shows that the three groups' distributions were associated with skewness and kurtosis between +2 and -2 (George & Mallery, 2010). According to George and Mallery these values are considered acceptable in order to prove normal distribution.

Table 2. Skewness and Kurtosis values.

N	Valid	87
	Missing	2
Skewness		-,204
Std. Error of Skewness		,258
Kurtosis		-,833
Std. Error of Kurtosis		,511

Figure 1 below also shows a visual representation of the normal distribution and confirms that the assumption is met.

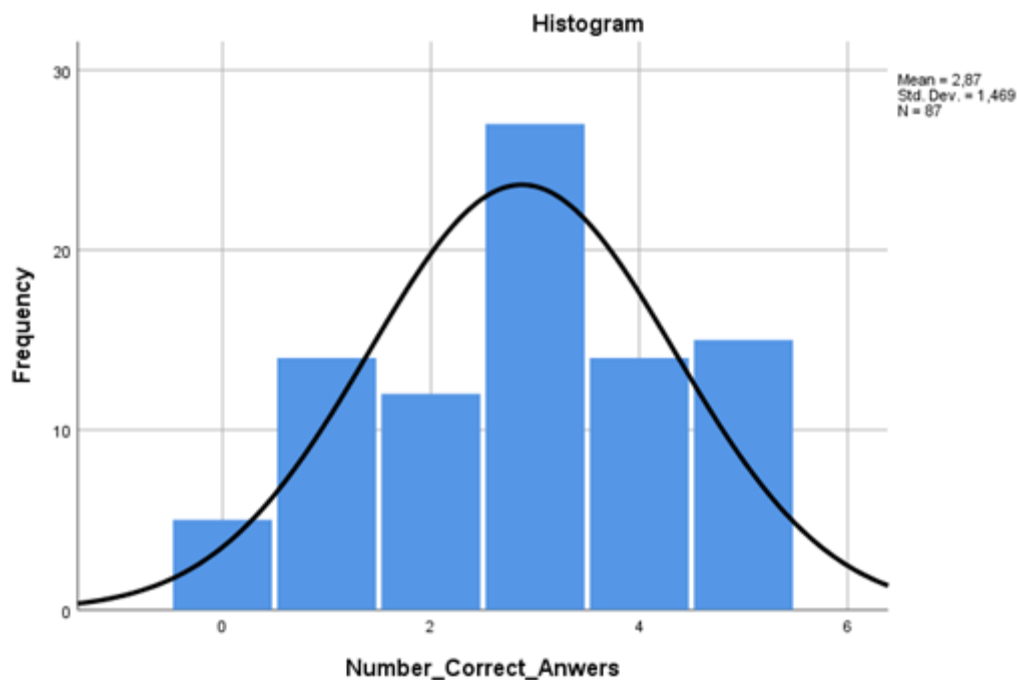


Figure 1. Visual representation of normal distribution.

Furthermore, the assumption of homogeneity of variance was tested and found tenable using Levene's F test. The F value for Levene's test was 2,85 with a Sig. (p) value of 0,093. The results are also presented in Table 3. These results are tenable because the significance level is above .05 meaning these values are not significant and this assumption is met as well.

Table 3. Results of the Test of Homogeneity of Variances.

Test of Homogeneity of Variances				
		Levene Statistic	df1	df2
Number_Correct_Answers	Based on Mean	2,448	2	84
	Based on Median	2,000	2	84
	Based on Median and with adjusted df	2,000	2	81,502
	Based on trimmed mean	2,396	2	84
Test of Homogeneity of Variances				
		Sig.		
Number_Correct_Answers	Based on Mean	,093		
	Based on Median	,142		
	Based on Median and with adjusted df	,142		
	Based on trimmed mean	,097		

For the comprehensibility task the independent variable, modal density, included three groups: Gestures and multiple additional modes of communication ($M = 2,76$, $SD = 1,455$, $N = 29$), Gestures only ($M = 3,41$, $SD = 1,150$, $N = 29$), and No Gestures ($M = 2,45$, $SD = 1,639$, $N = 29$). This can be read in Table 4 which shows the descriptive statistics results.

Table 4. Descriptive statistics for number of correct answers across the modal density groups.

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound
Group 1 Modal density	29	2,76	1,455	,270	2,21
Group 2 Gestures only	29	3,41	1,150	,214	2,98
Group 3 No gestures	29	2,45	1,639	,304	1,83
Total	87	2,87	1,469	,158	2,56

Table 5 below shows the results of the one-way ANOVA. An analysis of variance showed that the effect of modal density on the number of correct answers was significant, $F(2,84) = 3,451$, $p = 0,036$.

Table 5. Results of the one-way ANOVA.

Number_Correct_Answers	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	14,092	2	7,046	3,451	,036
Within Groups	171,517	84	2,042		
Total	185,609	86			

This shows that some significance was found in the ANOVA overall. This research, however, is more interested in the contrast between the three groups. The results of the post hoc test

below show this more clearly.

Post hoc comparisons were conducted with the use of Tukey HSD test. Table 6 below shows the results of the Post-Hoc tests from the one-way ANOVA for the comprehensibility test. This shows the contrast between the three different groups.

Table 6. Results Post-Hoc test. Multiple Comparisons. Comprehensibility test.

(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.
Group 1 Modal density	Group 2 Gestures only	-,655	,375	,194
	Group 3 No gestures	,310	,375	,687
Group 2 Gestures only	Group 1 Modal density	,655	,375	,194
	Group 3 No gestures	,966*	,375	,031
Group 3 No gestures	Group 1 Modal density	-,310	,375	,687
	Group 2 Gestures only	-,966*	,375	,031

*, The mean difference is significant at the 0.05 level.

These results show that no significant difference was found between Group 1 Modal density and any of the other two groups. Group 2 Gestures only shows a significant difference with Group 3 No gestures. The mean difference is significant at the 0.05 level and the difference between these groups is 0.031, meaning a significant difference was found between Group 2 Gestures and Group 3 No gestures ($p < .05$). This means that participants produced more correct responses in the condition with gestures than in the condition without gestures.

Figure 2 below shows a visual representation of the results from the Post-Hoc test showing the contrasts between the groups. The means plot shows the comparison of the mean scores between the three groups.

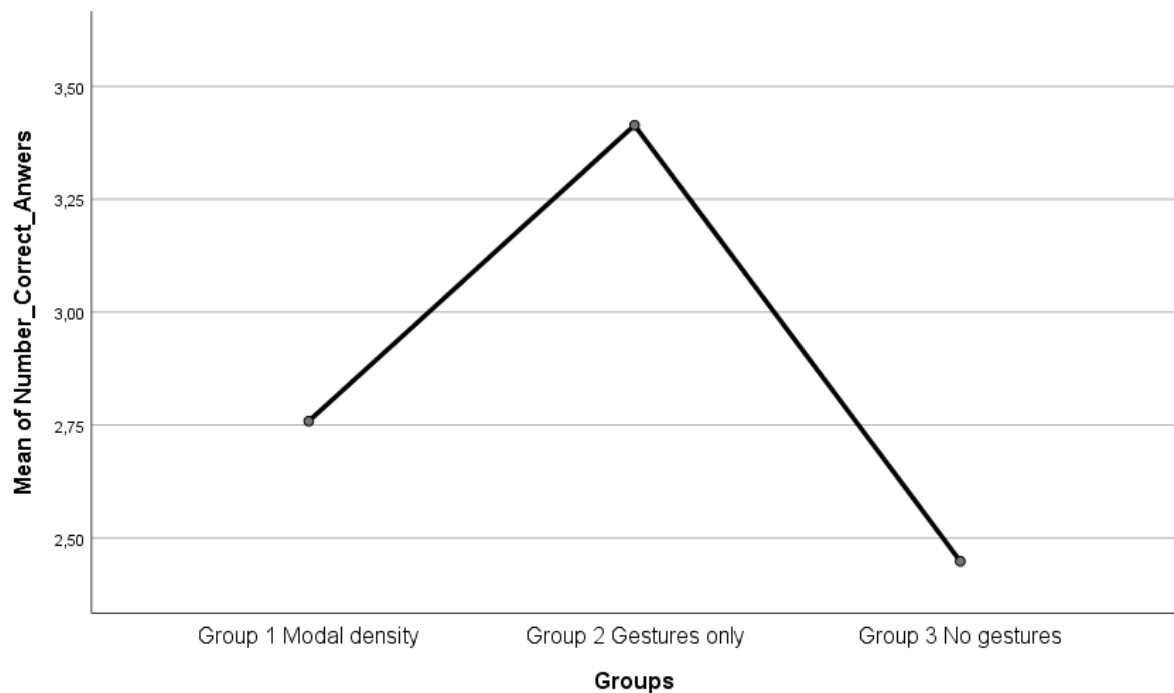


Figure 2. Visual representation of the results of the contrasts between groups for the comprehensibility task. Means Plot

Eventhough statistical significance was obtained, other factors need to be taken into consideration. For example, the effect size of this data set was 0.075. Based on Cohen's effect sizes this effect size can be considered small ($d < 0.2$) (Cohen, 1988).

4.2 Results memory test

For the second test, the memory test, the assumptions of normality and homogeneity of variance were evaluated prior to conducting the ANOVA as well.

The assumption of normality was checked and determined to be satisfied. Based on the results shown in Table 7, which shows that the three groups' distributions were associated with skewness and kurtosis between +2 and -2 (George & Mallery, 2010). According to George and Mallery these values are considered acceptable in order to prove normal distribution.

Table 7. Skewness and Kurtosis levels

Number_Correct_Answers		
N	Valid	54
	Missing	0
Skewness		,239
Std. Error of Skewness		,325
Kurtosis		-1,019
Std. Error of Kurtosis		,639

Figure 3 below also shows a visual representation of the normal distribution and confirms that the assumption is met.

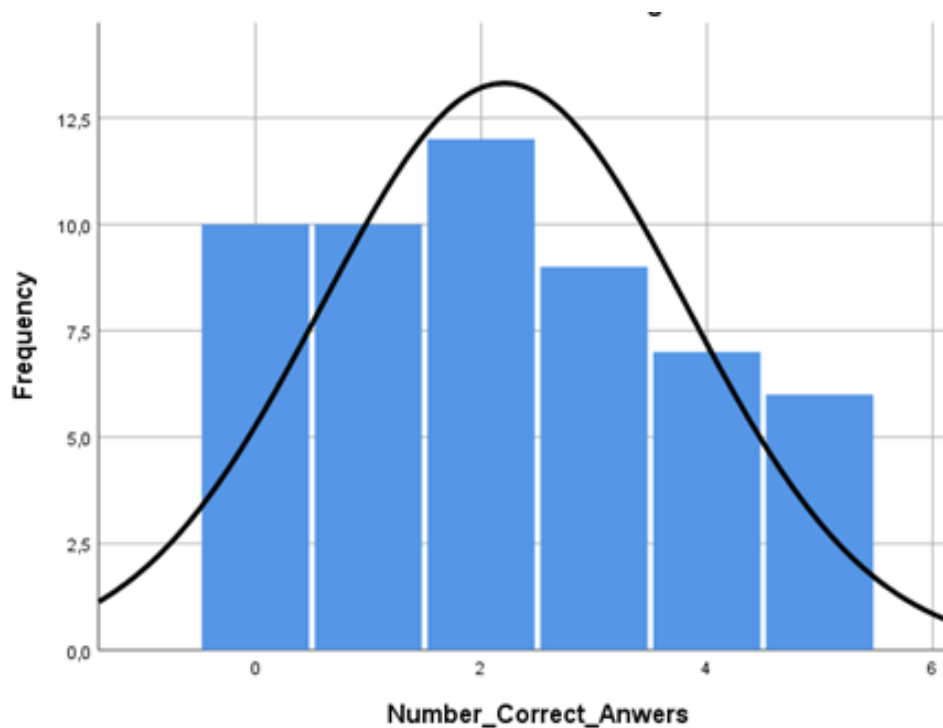


Figure 3. Visual representation of normal distribution

Furthermore, the assumption of homogeneity of variance was tested and found tenable using Levene's F test. The F value for Levene's test was 2,51 with a Sig. (p) value of 0,832. The results are presented in Table 8. These results are tenable because the significance level is above .05 meaning these values are not significant and this assumption is met as well.

Table 8. Results of the Test of Homogeneity of Variances.

Test of Homogeneity of Variances				
		Levene Statistic	df1	df2
Number_Correct_Answers	Based on Mean	,185	2	51
	Based on Median	,170	2	51
	Based on Median and with adjusted df	,170	2	50,837
	Based on trimmed mean	,178	2	51

Test of Homogeneity of Variances			Sig.
Number_Correct_Answers	Based on Mean		,832
	Based on Median		,844
	Based on Median and with adjusted df		,844
	Based on trimmed mean		,838

For the memory test the independent variable, modal density, also included three groups; Gestures and multiple additional modes of communication ($M = 2,00$, $SD = 1,534$, $N = 18$), Gestures only ($M = 2,72$, $SD = 1,674$, $N = 18$), and No Gestures ($M = 1,89$, $SD = 1,605$, $N = 18$). These are shown in Table 9 below.

Table 9. Descriptive statistics for number of correct answers across the modal density groups.

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound
Group 1. Modal density	18	2,00	1,534	,362	1,24
Group 2. Gestures only	18	2,72	1,674	,394	1,89
Group 3. No Gestures	18	1,89	1,605	,378	1,09
Total	54	2,20	1,618	,220	1,76

Table 10 below shows the results of the one-way ANOVA. An analysis of variance showed that the effect of modal density on the number of correct answers was not significant, $F(2,51) = 1,430$, $p = 0,249$.

Table 10. Results of the one-way ANOVA

Number_Correct_Answers					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7,370	2	3,685	1,430	,249
Within Groups	131,389	51	2,576		
Total	138,759	53			

This shows that no significance was found in the ANOVA overall. This research, however, is more interested in the contrast between the three groups. The results of the post hoc test below show this more clearly.

Post hoc comparisons were conducted with the use of a Tukey HSD test. Table 6 below shows the results of the post hoc test from the one-way ANOVA for the memory test. This shows the contrast between the three different groups.

Table 11. Results Post-Hoc test. Multiple Comparisons. Memory test.

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.
Group 1. Modal density	Group 2. Gestures only	-,722	,535	,375
	Group 3. No Gestures	,111	,535	,977
Group 2. Gestures only	Group 1. Modal density	,722	,535	,375
	Group 3. No Gestures	,833	,535	,273
Group 3. No Gestures	Group 1. Modal density	-,111	,535	,977
	Group 2. Gestures only	-,833	,535	,273

*, The mean difference is significant at the 0.05 level.

These results show that no significant difference was found in this test. No significant difference was found between Group 1 Modal density and any of the other two groups and Group two Gestures only does not show a significant difference with Group 3 No Gestures. Figure 4 below shows a visual representation of the results of the Post-Hoc test showing the contrasts between the groups. The means plot shows the comparison of the mean scores between the three groups.

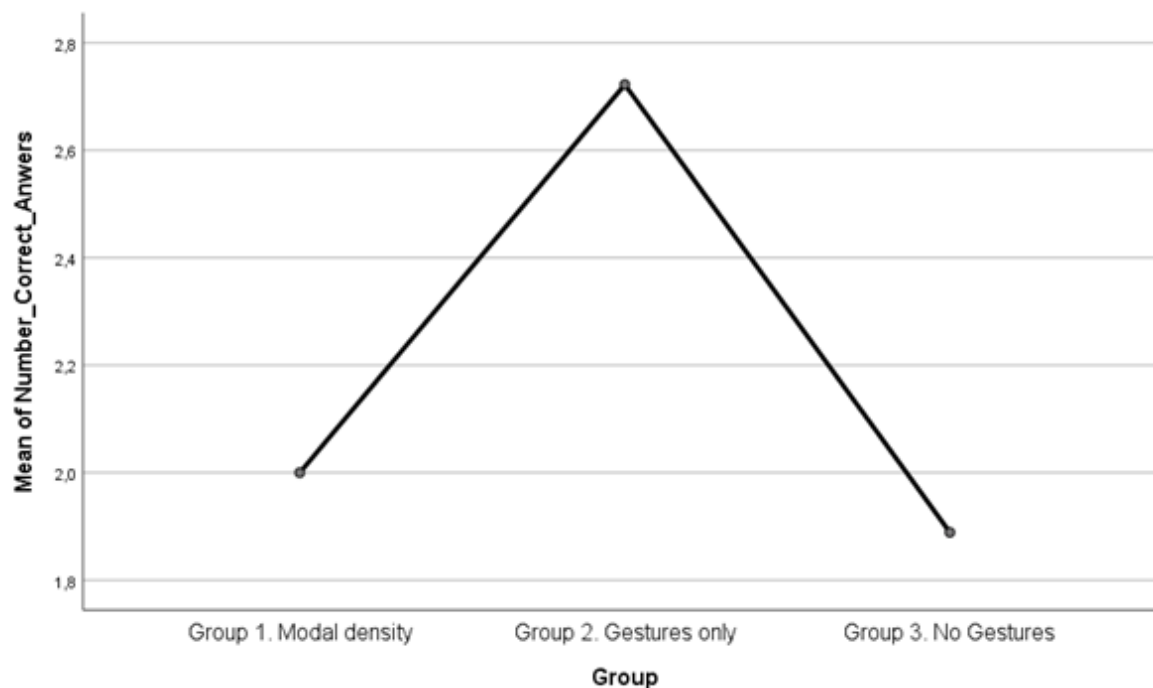


Figure 4. Visual representation of the results of the contrasts between groups for the memory test. Means Plot.

The effect size for this test was 0,053, which can also be considered a small effect size based on Cohen's effect size ($d < 0.2$) (Cohen, 1988).

5. Discussion

This study was conducted in order to investigate whether gestures and multiple additional modes of communication influenced comprehensibility and memory of action sequences. The research questions guiding this research were: “To what extent does the perception of gestures and multiple additional modes of communication influence comprehensibility of action sequences?”, and “To what extent does the perception of gestures and multiple additional modes of communication influence memory of action sequences?”. The hypotheses were: “Comprehensibility of action sequences will significantly improve as modal density increases.”, and “Memory of action sequences will significantly improve as modal density increases.”.

The results of the comprehension test showed a significant difference between the second group, gestures only, and the third group, no gestures. On the other hand, no significant difference was found between the first group, gestures and multiple additional modes of communication, and any of the other groups. This refutes the hypothesis to some extent that an increase in modal density will also cause for an increase in comprehensibility of action sequences. However, the first part of the findings, between the second and third groups, does confirm the hypothesis to some extent. These findings are expected when considering the literature. The integrated-systems hypothesis by Kelly, Özyürek, and Maris (2010) already suggested that when one of the two modes, speech or gestures, is missing, comprehension is disrupted. As Beattie and Shovelton (1999) have shown in their study, it would be expected that the use of gestures causes for an increase in comprehensibility. Another paper by Beattie, Shovelton, and Holler (2009) confirms this claim that gestures contribute additional semantic information alongside speech output and therefore contribute to comprehension. Gestures improving compressibility is also shown in a study by Dooling and Lachman (1971). Their study has shown that participants showed an increase in comprehensibility and memory

of a text when this text got presented with context in the form of a title. As Schegloff (1984) mentions in his study, gestures tend to precede the words that lexically correspond them and therefore gestures can be seen as a sort of context. This should cause for an increase in comprehensibility of action sequence when provided with gestures.

The unexpected findings that no significant differences were found between the first group with gestures and multiple additional modes of communication and the other two groups can be accounted for. This is attributable to the amount of attention paid. When a social actor is performing two or more tasks simultaneously, research has shown that people generally make more mistakes (Wallis, 2006). Attention is divided between tasks causing for both, or multiple, tasks to be performed at a lower level. When a social actor is paying attention to more than one stimulus or to more than one modality this can be called divided attention (Graves & Lau, 2010). When a social actor, like in the present study, is paying attention to both visual and auditory input both require an amount of attention. Moisala, Salmela, Salo, Carlson, Vuontela, Salonen, and Alho (2015) have shown that when a social actor is using divided attention to auditory and visual input, comprehension of sentences is lower when the modes provide the listener with different semantic information. Participants in their study were asked to do a sentence comprehension task in which they had to grade several sentences on comprehensibility. They found that participants who were exposed to both auditory and visual input considered the sentences less comprehensible than the participants who were only exposed to one form of input. This can be linked to the idea of divided attention. When a social actor pays attention to multiple forms of input or multiple modes of communication, their attention needs to be divided between them causing for a lower comprehensibility of the modes.

Divided attention also occurs in the present research. In the third group; no gestures used, the participants only had to pay attention to the speech output. Only one form of input

required attention. In the first and the second groups the participants had to pay attention to the speech output and the accompanying gestures and additional modes of communication. This means that their attention was divided between two forms of input, visual and auditory. The argument that more attention paid causes for higher comprehension fails and this would suggest that speech alone would cause for the highest comprehensibility, because semantics is critical to comprehension. Golinkoff and Rosinski state in their study (1976) that two skills are crucial for comprehension of information: decoding, the ability to pronounce words out loud, and semantic processing, obtaining the meaning of individual words. A social actor must be able to understand the meaning of a word/sentence in order for it to be comprehensible. Speech output alone provides the hearer with semantic information about the story and would therefore contribute to comprehension. However, referring back to the arguments above that gestures contribute to the communication of semantic information, both speech and gestures provided the participants with information about the story. So all the attention paid, either to the gestures or to the speech output, contributed to their understanding of the story. Compared to the third group, where speech output was the only mode communicating semantic information, two modes of communication now provided semantic information and therefore contributed to comprehensibility. This accounts for a higher comprehensibility for the second group; gestures only.

For the first group; gestures and multiple additional modes of communication, the participants had to divide their attention between speech output, gestures, and the additional attention-grabbing modes. Gestures provided the hearer with additional semantic information, but the other modes of communication with their main function being grabbing attention from the hearer did not contribute to the communication of semantic information. Although the participants might have paid more attention to these propositions in general because of the use of these additional modes of communication, they might have actually distracted the

participants from the information told in the story. Semantics is crucial for comprehension and when less semantic information is communicated because of divided attention, comprehension will be lower (Golinkoff & Rosinski, 1976).

The results of the memory test show no significant differences between any of the three groups. This refutes the second hypothesis that memory of action sequences will improve significantly as modal density increases. As shown in Dooling and Lachman's study (1971), comprehension is crucial for memory. They found that participants in their study who did not comprehend the text in the first place, scored lower on the memory test as well. Since the participants in this study did not fully comprehend parts of the story, especially for the first and third group, it would be unlikely for them to remember it as well. Mackay (1973) provides a theory on why comprehension is crucial for memory. He shows that when a sentence is comprehended it is processed in the short-term memory. For memory, this information is then transferred to the long-term memory. He claims that when something is not fully comprehended it does not get processed in the short-term memory and this would mean that there is no chance of the information being transferred to the long-term memory. However, the second group; gestures only, did show a relatively high level of comprehension. It would therefore have been expected that this group scored significantly higher on memory as well.

Referring back to Figure 4, a difference can be seen between the second group; gestures only, and the other two groups. Although this difference is not found significant, Figure 4 does show that there is potential for further research. What Figure 4 suggests to some extent is that group two; gestures only, benefits from the use of gestures for memory retention. This is in agreement with the literature mentioned in the literature review that an increase in modal density also causes for better memory retention. The stimulus in group one, on the other hand, also showed an increase in modal density. However, the divided attention

caused by the ‘distracting’ additional modes of communication not providing the participants with semantic information about the story caused for a lower comprehension. When the participants achieve lower comprehension caused by divided attention, memory retention will be obstructed.

The fact that no significant difference was found in the second test can be attributed to some faults in the methodology of this study. First, to make use of a classroom setting might have had a negative influence on the attention paid by the participants, because this might have caused for distractions and the participants could have spoken to one another about their answers somewhere in-between the first and second testing moments. To make use of a classroom setting was solely for the purpose of time. Unfortunately, not enough time was available to get every participant to take the test individually. Further research should take this into consideration and conduct the experiment separately for each participant.

Another issue with the methodology was the sample size. The first test consisted of 29 participants whereas the second test only consisted of 18 participants. This dissimilitude in the number of participants was unfortunately caused by the fact that only 18 participants filled out the question list that was distributed online. This difference in number of participants caused the study to be unreliable and could have caused for the unexpected outcome of the memory test. A participant population of 29 participants is a small number of participants and further research should be conducted with a much larger number of participants before anything can be safely concluded about the influence of modal density on comprehension and memory.

The participants in this study were all first-year students of English language and culture at Radboud University. As mentioned in the methodology section these students have a proficiency level somewhere between B2 and C1 based on the Common European Framework of Reference for Languages (2001). This means that the participants had a relatively high level of English but were not near-native or native speakers of English.

Therefore, they might have needed to pay more attention to the information conveyed in the story compared to native speakers. The additional modes of communication ‘distracting’ attention from the content of the narrative might have accounted for the lower comprehensibility for the first group compared to the second group. Native speakers do not have to pay the same amount of attention to the video stimulus as speakers with a lower proficiency and comprehensibility would not be influenced. Therefore, further research could be done with a similar method using native speakers as participants. This way, the divided attention would be less and the influence on the results would be expected to be smaller.

6. Conclusion

This thesis dealt with the following research questions: “To what extent does the perception of gestures and multiple additional modes of communication influence comprehensibility of action sequences?”, and “To what extent does the perception of gestures and multiple additional modes of communication influence memory of action sequences?”. The hypotheses were: “Comprehensibility of action sequences will significantly improve as modal density increases”, and “Memory of action sequences will significantly improve as modal density increases”.

In order to answer the research questions an experiment was conducted including two separate testing moments. The first was the comprehensibility test and included 29 participants. The participants were asked to watch a video stimulus which included several action sequences from the show ‘Tweety and Sylvester’. The video contained several sentences which were told with three different levels of modal density; gestures and multiple additional modes of communication, gestures only, and no gestures. Afterwards, the participants were asked to answer 15 questions about the video they had just watched. The memory test was distributed online three days later and consisted of the same question list which was filled out by 18 participants. The data from both tests were analysed by means of a one-way between groups ANOVA.

The results showed that the hypothesis for the comprehensibility test was refuted to some extent, but not entirely. Significant differences were found between the group with gestures and the group with no gestures. This shows that an increase in modal density causes for higher comprehension of action sequences. Modal density only causes for an increase in comprehension, however, when the additional modes of communication communicate semantic information. The participants in this study were not native speakers of English and the additional attention-grabbing modes might have distracted from the information conveyed

in the story. Because the participants were not native speakers of English they had to divide their attention between the different modes causing for lower comprehension. A similar experiment with native speakers of English might show different results.

The hypothesis for the memory test was refuted. No significant differences were found between any of the three groups. Comprehension is found critical for memory and since the participants in this study did not fully comprehend the story in the first place, due to divided attention, it was unlikely for them to remember it as well.

The answer to the first research question is that comprehensibility of action sequences is positively influenced by modal density to the extent of gestures communicating semantic information. More additional modes of communication do not contribute to comprehensibility but rather form an obstruction. The answer to the second research question is that memory of action sequences does not improve as modal density increases. However, in order to conclude anything with certainty more research with native speaker of English and a bigger sample size is needed.

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Appendices

Appendix 1: written out narrative of action sequences:

Modal density

Gestures only

No gestures

Tweety is sitting in his house on top of a pole. Sylvester is sitting at the bottom thinking of way to get into Tweety's house. He builds a large trampoline to get into Tweety's little wooden house. He jumps really high until he's in front of Tweety's house. Tweety sees him and punches him in the face. Sylvester tries again and Tweety splashes water in his face. The third time that Sylvester flies in the air Tweety puts a little bomb into his helmet and the bomb explodes.

Sylvester tries something else because this did not work so:

Sylvester tries to cut down the pole with Tweety's house on it to make it fall. Tweety sees this and connects a thread to another place. He slides down the thread, but he has attached it to Sylvester's teeth. So he is heading towards Sylvester's mouth. Tweety notices this and changes himself for a little bomb again. He just flies away. After the bomb explodes Sylvester's mouth is very soft and has no teeth in it.

After this Sylvester cannot find Tweety anymore because

Tweety is hiding in a bucket full of tennis balls. A human passes by and reaches for the bucket. Tweety is used as a tennis ball flying back and forth. Sylvester is looking over the fence and gets into the playing field dressed like a tennis player. He tries to catch Tweety in his mouth. But Tweety throws a little bomb into his mouth. Sylvester drinks a lot of water to stop the bomb.

Appendix 2: Question list for both tests.

1. What is Sylvester trying to think of?
2. What does Sylvester build to get into Tweety's house?
3. What does Tweety do the first time he sees Sylvester in front of his house?
4. Where does Tweety put the bomb when he sees Sylvester in front of his house?
5. What happens to the bomb?
6. What is Sylvester trying to cut down?
7. What does Tweety do with the thread he has connected?
8. To what has Tweety attached the thread?
9. Towards what is Tweety heading?

10. How does Tweety escape from Sylvester's mouth?
11. What has happened to Sylvester's mouth after the bomb has exploded?
12. Where is Tweety hiding from Sylvester?
13. What does the human reach for when he passes by?
14. As what is Tweety used by the humans?
15. What does Sylvester do to stop the bomb?