The Effect of Typical and Atypical Gestures on Adult Narrative Comprehension

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Abstract

The gestures that learners both observe and produce can aid learning. Little is known, however, about whether observing and spontaneously producing gestures assists adults in understanding narratives. Furthermore, there is a lack of research into the differential impacts of different *types* of gestures on narrative comprehension. This study therefore explores the role that observing and producing different types of gestures has in assisting adult narrative comprehension. Participants viewed a videotaped narrative in one of three between-subjects conditions: with accompanying typical gestures (commonly used gestures), atypical gestures (non-typical gestures), or with no gestures. Half of the gesture and non-gesture points in the narrative were accompanied by complex words while the other half were accompanied by simple words, to determine whether observing gesture has a greater effect when a narrative is complex. Participants then answered free recall and follow-up questions about the narrative. Verbal and gestural recall of the narrative, and gestures spontaneously produced at recall were compared between conditions for simple and complex words. Further, the relationship between the production of gesture and verbal recall was examined. Results suggested that while typical gestures benefitted narrative comprehension to a greater extent than no gestures, atypical gestures were not beneficial for recall. There was no interaction between complexity and gesture condition. The number of typical gestures, but not the number of atypical or other gestures produced at recall, significantly predicted narrative comprehension. Findings from the current study suggest that not all gestures are equal: both viewing and producing typical gestures can benefit narrative comprehension, while atypical gestures may be of little benefit.

Declaration of Originality

The works found within this thesis have not been submitted for a higher degree to any other university or institution. All empirical research contained within this thesis was approved by the Human Research Ethics Committee at Macquarie University (reference number: 5201500047).

Signature of Candidate:

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The Effect of Typical and Atypical Gestures on Adult Narrative Comprehension

Our ability to communicate with one another crucially impacts our day-to-day interactions (Littlejohn & Foss, 2010). Although "communication" is often used as shorthand for verbal, spoken messages, the non-verbal component of communication, including hand gestures, can be similarly important. Gestures, defined as movements made by the hands or arms (Holstetter & Alibali, 2007), provide an external support to oral communication, and in doing so, have the potential to benefit learning by an observer (McNeil, Alibali, & Evans, 2000). While the beneficial role of gesture has been made apparent for both problem solving (Alibali & DiRusso, 1999; Chu & Kita, 2011; Goldin-Meadow, Cook, & Mitchell, 2009; Ping & Goldin-Meadow, 2008) and speech comprehension (Driskell & Radke, 2003), little research has been conducted in the area of narrative comprehension (Dargue, 2014).

Narrative comprehension can be defined as an individual's ability to interpret and make meaning of a presented story, and is an important, if not the most important, cognitive tool for human development (Hough, 1990; Lyle, 2000; Schmithorst, Holland, & Plante, 2006). Humans use narrative to create meaning out of actions and events, demonstrating that the ability to comprehend narratives dominates the way that humans relate to, and communicate with one another (Lyle, 2000). Although narrative comprehension is important to young children, allowing children to narrate their own needs and feelings, as well as understand those of others (Paris & Paris, 2003), narrative comprehension is similarly crucial to adults. The ability to comprehend narratives can enhance one's understanding of moral and ethical concepts important in professional practice, such as in the diverse fields of education, medicine, or law (Lyle, 2000). Consequently, understanding whether gesture is beneficial to narrative comprehension could have valuable repercussions for development and learning across the lifespan.

Given that gesture plays an advantageous role in other aspects of learning, including comprehension of a spoken message (Driskell & Radke, 2003), it is likely that the observation of gesture will aid narrative comprehension. However, not all gestures are created equal. If we are to learn from gestures, the types of gestures observed or produced are likely of importance. Concrete, meaningful (iconic) gestures play a crucial role in the evolution of language (Arbib, Liebel, & Pika, 2008), and it may be that some iconic gestures are more helpful than others. I will discuss here first, commonly classified different types of gestures. Second, I will discuss how gestures may be beneficial to learning. Then finally, I will make a rarely discussed distinction between gestures that humans may be inherently primed to use and understand, as compared with perhaps artificial gestures that may be of less benefit to learning.

Gesture Classification

Before discussing how gestures may be of benefit to learning, it is important to differentiate between the various forms of gestures typically produced during speech. Gestures can be broadly classed as deictic, metaphoric, beat, or iconic in nature. Deictic gestures are pointing gestures, and function as a means of communicating an event or indicating an object (McNeill, 1992). A person pointing to a dog while saying “puppy” provides an example of a deictic gesture, as the person is indicating the presence of a dog by pointing towards it. On the other hand, a gesture that serves as an expression of an abstract metaphor is defined as a metaphoric gesture (Ciekni & Müller, 2008). A person saying that their grades have improved while gesturing in an upward motion is an example of a metaphoric gesture, as the upward motion symbolises an improvement. In contrast, beat gestures are defined as rhythmic movements produced by the hands that are not related semantically to the events or objects highlighted through accompanying speech (McNeill, 2000). A person moving their hands in a flicking motion while saying “book” is an example of a beat gesture, as the flicking motion bears no semantic relation to a book. Finally, iconic gestures are defined as gestures that exhibit a concrete meaning, typically an action or an object, which is semantically related to the content of speech (Beattie & Shovelton, 1999). A person moving one hand in an upward motion while saying “the plane flew up into the sky” is an example of an iconic gesture, as the gesture portrays the action of the plane rising upwards and is therefore semantically related to the associated speech content. Iconic gestures are the focus of the present study.

Self-Oriented and Other-Oriented Gestures. In addition to being classified as deictic, metaphorical, beat, or iconic as outlined above, gestures can also be categorised as self-oriented or other-oriented. That is, gestures that are both observed by a learner or performed by a learner have the ability to serve a communicative function (Kimbara, 2006). A self-oriented gesture is one that functions to aid the individual who performs the gesture (Kita, 2000), such as an individual counting using their fingers. In contrast, an other-oriented gesture is one that functions to aid the individual observing the gesture (Kita, 2000), such as an individual waving to another to say hello. Both self-oriented and other-oriented gestures may have an impact on learning, and will both be investigated in the present study.

Gesture and Learning

Self-Oriented Gestures and Learning. Self-oriented gesture, whereby an individual uses gesture themselves to aid the task at hand, has been shown to benefit spatial problem solving tasks, mathematical problem solving tasks, learning how to count, and narrative comprehension (Alibali & DiRusso, 1999; Chu & Kita, 2011; Goldin-Meadow, et al., 2009; Dargue, 2014). Spatial problem solving is a key aspect of communication, and is related closely to mathematical and scientific achievement (Humphreys, Lubinski, &Yao, 1993). In a study using university students, Chu and Kita (2011) found that participants who produced gestures when solving a difficult mental rotation task performed significantly better than participants who did not produce gestures. As the produced gestures functioned to aid the participant (i.e., were self-oriented), the study conducted by Chu and Kita indeed supports the notion that self-oriented gestures can benefit learning.

Further support for this notion comes from Goldin-Meadow et al. (2009), who studied whether self-oriented gestures aid mathematical problem solving. As mathematical problem solving is synonymous with the ability to solve problems and create patterns, an understanding of the mechanisms that benefit mathematical problem solving is of importance to education and learning (Wilson, Fernandez, & Hadaway, 1993). Goldin-Meadow et al. instructed children aged 7 to 9 to either gesture or not gesture when solving a mathematical problem. The results of this study showed that children who produced gestures when solving a mathematical problem performed significantly better than children who did not produce gestures, suggesting that the use of self-oriented gesture can benefit mathematical problem solving in children. In addition, Alibali and DiRusso (1999) investigated whether self-oriented gesture is beneficial in learning how to count, a skill which is essential in building a solid foundation for early mathematics. Using preschool children, Alibali and DiRusso found that children who actively gestured when counting were significantly more accurate than children who did not produce gestures when counting. This suggests that in addition to aiding spatial and mathematical problem solving, the use of self-oriented gestures may be of benefit to counting.

While limited in scope, preliminary research suggests that self-oriented gesture may be of benefit to narrative comprehension. A key feature of communication is that the listener is able to make sense of a spoken message or narrative (Emmott, 1997). While it is difficult for someone to remember a spoken narrative perfectly, by being able to recall a larger quantity of a spoken narrative, a listener is more likely to integrate information from different aspects of the story (Emmott, 1997). This integration of information helps the listener to form a mental representation, thereby increasing their comprehension (Emmott, 1997). As narrative comprehension is of great importance to human development as outlined above, it is important to understand any tools that may be used to improve such comprehension.

Children and adults have been shown to use both speech and gesture while retelling a story (Dargue, 2014; Demir, 2009; McNeill, 1992), with the gestures produced functioning to aid cohesion and coherence of the spoken narrative (Demir, 2009). Demir (2009) noted that the spontaneous gestures produced by 5 year-old children when retelling a previously viewed Tom and Jerry cartoon seemed to reflect an understanding of narrative structure. That is, children who produced gestures when recalling the Tom and Jerry cartoon seemed to produce a more structured narrative. As recall and comprehension are a function of narrative structure (Thorndyke, 1977), it may be that the more structured narratives produced by children who gestured at recall represent a beneficial function of self-oriented gestures on narrative comprehension in young children.

Further, Dargue (2014) coded the gestures that university students produced while retelling a narrative that they were shown earlier. It was found that the production of spontaneous self-oriented gestures positively predicted narrative comprehension as measured through recall in these participants, suggesting that the self-oriented use of gesture may be related to an increase in narrative comprehension in adults. Thus, the studies by Demir (2009) and Dargue (2014) allude to the probability that the use of self-oriented gestures may aid narrative comprehension. However, it is not clear whether there are any factors which in and of themselves might influence the extent to which individuals produce self-oriented gestures at recall. For example, it is not clear whether the types of gestures produced might influence how beneficial those gestures are for recall, a possibility that is further discussed below.

Both children and adults have been shown to imitate the non-verbal behaviour of an individual with whom they are conversing (i.e., their gestures; Cook & Goldin-Meadow, 2006). In consideration of this imitative behaviour, it is possible that by viewing a narration in which the narrator produced gestures while telling a story, individuals may produce a greater frequency of gestures when recalling the narrative. Further, individuals may produce the specific gestures they saw performed in the narrative. This imitation of the narrator's gestures may indeed lead to an improvement in the narrative comprehension of the individual retelling the story and will be investigated in the current study. The noted beneficial effects of self-oriented gestures on learning raises the issue of exactly *how* such gestures benefit learning.

Self-Oriented Gesture and Working Memory Load. One theory behind how self-oriented gesture may benefit learning is that the production of gesture reduces the demands placed on working memory (Cook, Yip, & Goldin-Meadow, 2012). Working memory resources can influence the performance of tasks that are cognitively challenging, as working memory provides a temporary store for information (Baddeley, 1992). Insufficient working memory resources can therefore reduce individuals' ability to complete the task at hand, if they do not have the capacity to hold all elements relevant to the task in working memory. Conversely, individuals' ability to learn may be improved if information is presented to them in such a way that reduces the load placed on working memory (Cook, Mitchell, & Goldin-Meadow, 2008). Thus, if the use of self-oriented gesture by a speaker decreases the load placed on working memory, it may allow for more resources to be allocated to the learning task, and may therefore benefit completion of the task (Cook et al., 2012). If the use of self-oriented gestures indeed lowers the load placed on working memory, it may be that individuals who produce a greater number of gestures when recalling the narrative will have a greater understanding of the narrative and thus higher scores on a recall task. While working memory load is not explicitly measured during the current study, given the connection between gesture production and working memory, it is reasonable to propose that the use of self-oriented gesture may benefit narrative comprehension.

While the use of self-oriented gesture to reduce the load placed on working memory provides one potential explanation underlying the beneficial effects of gesture on learning, it does not account for the benefits of other-oriented gestures. The beneficial role of other-oriented gestures (i.e., gestures that function to aid an observer rather than a speaker) will now be discussed, followed by a discussion of the potential mechanisms underlying the beneficial effects on learning of such other-oriented gestures.

Other-Oriented Gestures and Learning. Other-oriented gesture, whereby an individual produces a gesture to benefit an observer, has been shown to aid the observer’s speech comprehension (Driskell & Radke, 2003), problem solving (Ping & Goldin-Meadow, 2008), and narrative comprehension (Dargue, 2014). Speech comprehension is a building block from which an individual’s native language develops (Tallal et al., 1996). Driskell and Radke (2003) studied the benefit of other-oriented gestures on speech comprehension using adults from the U.S. Naval Reserve military. Participants guessed which word an individual was conveying to them, based either on a single word clue accompanied by a gesture, or just a single word clue with no accompanying gesture. It was found that participants were more likely to guess the word correctly if the one word clue was accompanied by gesture, compared with the verbal cue on its own. These results suggest that the use of gesture by a speaker can improve an observer’s speech comprehension, supporting the notion that other-oriented gestures may benefit learning.

In addition to the research noted above which suggests that problem solving can be aided by self-oriented gestures, there is also evidence to suggest that other-oriented gestures may play a beneficial role in problem solving. Problem solving is important to our ability to solve novel challenges as they arise. For example, Ping and Goldin-Meadow (2008) demonstrated that children aged 5 to 7 learnt significantly more about conservation tasks when given instructions using both gesture and speech compared with speech alone. Children were taught that just because one container is taller than another, it does not mean that the first container holds more liquid. When given the solution with gestures accompanying speech, the children were able to solve these types of problems more easily when compared to being given the solution with speech alone. Thus, the observation of gesture may indeed benefit problem solving.

Another aspect of learning that may be assisted by other-oriented gesture is the area of narrative comprehension. Due to the important role narrative comprehension plays in understanding moral and ethical concepts in a professional setting (Lyle, 2000), it is crucial to understand what factors may improve narrative comprehension in adults. Limited research has investigated the role of other-oriented gesture in narrative comprehension. One study by Dargue (2014) investigated whether observing gesture produced by a narrator in a video improved narrative comprehension in preschool-aged children and adults. It was found that gestures which reinforced the speech content of the narrative improved narrative comprehension in children but not adults. While this finding suggests that gestures may aid narrative comprehension in children but not in adults, it may be that no effect was found for the adults due to the narrative being too simple, meaning no beneficial effects of gesture could be detected.

Gesture and Task Complexity. Research on the effect of other-oriented gestures on learning has tended to find more beneficial effects when investigated with children than with adults (e.g., Austin & N. Sweller, 2014). It is possible that this inconsistency of results between children and adults may be due to differences in the complexity of a task, rather than some inherent developmental difference in how children and adults process gesture and speech. That is, no effect of gesture may be found for adults due to the tasks used in previous studies being too simple, meaning no improvements are possible from observing gesture. A study by McNeil et al. (2000) looked at the effect of gestures on speech comprehension when a spoken message was either simple or complex using preschool aged children and children in their first year of school. When a spoken message accompanied by gesture was complex for preschool children but simple for children in their first year of school, the gestures aided speech comprehension only for the preschool aged children. No effect of the gestures was found for children in their first year of school. When the spoken message was similarly simple for preschool aged children, however, the accompanying gestures had no effect on speech comprehension.

While this type of research is yet to be conducted on an adult population, it suggests that whether an observed gesture aids learning on a particular task may in part depend on the complexity of the task at hand. To fill this gap in the research, the current study aims to determine whether gestures aid narrative comprehension to a greater extent when the speech content of a narrative is complex in an adult population than when it is simple. However, if complexity of the task has no bearing on the extent to which gestures are beneficial to learning in adults, the way that gesture benefits learning may be more dependent on developmental differences in how children and adults process gesture and speech, rather than being an artefact of task complexity. Potential mechanisms underlying the beneficial effects of other-oriented gesture on learning will now be discussed, in the context of two proposed systems in which gesture and speech may be processed.

Gesture and Speech as an Integrated System. Iconic gestures are communicative, and when performed alongside speech may aid in the communication of ideas (McNeill, 1985). Iconic gestures may be reinforcing (i.e., a gesture that reinforces the content of speech), or contradictory (i.e., a gesture that contradicts the content of speech). Whether an iconic gesture reinforces or contradicts the content of speech may have differential effects on learning. According to McNeill (1992), speech and gesture may form two parts of a single, underlying verbal-gestural communication system. Evidence for such a system stems from research which shows that learning may be impaired when observing iconic hand gestures that contradict the content of speech (e.g., a person moving their hand upwards while saying “down to the ground”; McNeill, 1998).

A reduction in learning as a result of observing contradictory gestures is evidence for an integrated system, as it emphasises that individuals are processing both the gestural and spoken information simultaneously in an attempt to form a speech and gesture combination that match (McNeill, 1992). If contradictory gestures do not impair learning, there would instead be evidence that speech and gesture are processed separately, with judgement being placed more on the content of speech and the contradictory gestural content being ignored. A study conducted by Cassell, McNeill, and McCullough (1998) examined whether speech and gesture form a single underlying verbal-gestural communication system using university students. Participants watched a video of an individual narrating a story while performing reinforcing and contradictory gestures, and later retold the story. When retelling points in the narrative that corresponded with contradictory gestures, participants made significantly more errors compared to when retelling points in the narrative that corresponded with reinforcing gestures. As it is expected that contradictory gestures will have a detrimental effect on performance if speech and gesture indeed form an integrated system (McNeill, 1992), the finding by Cassell et al. that observing contradictory gestures leads to more errors when retelling a narrative supports this notion.

Gesture and Speech as Separate Modular Systems. While McNeill (1992) theorised that gesture and speech make up two parts of a single, underlying system, it is possible that speech and gesture form two separate entities, with speech being the dominant entity (Kelly & Church, 1998). In other words, gesture may supplement speech, but only if the content of the speech and gesture match. If the gestures and the content of speech differ, the observed gestures will be ignored and judgement will be made solely based on the content of speech.

Thompson and Massaro (1994) found speech had a significantly greater influence on learning than gesture when the gestures presented to preschool children were contradictory in nature. Children aged 4- and 9- years of age were presented with a video of a woman seated with an array of four objects placed in front of her. The woman in the video indicated through speech alone, gesture alone, or both speech and gesture combined which object the participant watching the video should choose across a number of trials. The speech in the combined condition either reinforced or contradicted the gestures that the woman performed during the video. Thompson and Massaro found that for the contradictory condition, preschool children tended to rely more on the speech component of the message, while older children were more influenced by the gestures.

If speech and gesture are indeed separate modalities, it would be expected that the contradictory gestures would not influence learning, as judgement would be based on the dominant entity of speech. While the results of Thompson and Massaro (1994) did indeed show that speech was more influential than gesture when the content of the speech and gesture differed in preschool children, gesture appeared to be more influential in the older children. In addition to the results of Cassell et al., (1998) who found a detrimental effect of perceiving contradictory gestures on learning in adults, it may be that the results of Thompson and Massaro (1994) and Cassell et al., (1998) reflect inherent underlying age differences regarding how speech and gesture are processed. That is, children may process speech and gesture as two separate modalities, while adults may process speech and gesture together as an integrated system.

While it could indeed be that adults process speech and gesture in a different manner to children, the complexity of the task to be completed could potentially alter how beneficial gesture is to adult learning. That is, if a task is too simple, the gestures may become redundant and thus not improve learning. To fill this gap in the literature, the present study aims to determine whether the complexity of the task may alter whether or not gesture can be beneficial to adult learning. Understanding whether the complexity of a given task affects how beneficial gestures are to learning will therefore help to clarify whether there are indeed differences between how children and adults process speech and gesture. That is, if gestures are found to aid adult learning when a task is complex but not when it is simple, it may be that prior research has used tasks that are too simple for adults, making the gestures redundant. Thus, such a result might suggest that it is the complexity of a task that determines whether gestures benefit adult learning, rather than developmental differences in the way that speech and gesture are processed.

Task complexity, however, may not be the only factor influencing the extent to which observing gestures may be beneficial for a learner. Whether a gesture is innate in nature or learnt through instruction could also have an impact on adult narrative comprehension. That is, there may be differential impacts on learning, dependent on whether an observed gesture is one that is universal, and performed naturally without instruction, in comparison with a gesture that is not innate and has instead been learnt through social interaction.

To this point, distinctions between deictic, metaphoric, beat, and iconic gestures have been made, as well as distinctions between self-oriented and other-oriented gestures and the effects that each have on learning. However, gestures may also be categorised as typical or atypical in nature. We turn now to examine the differences between innate, biologically primary skills and learnt, biologically secondary skills, and how iconic hand gestures themselves may be classed as innate or learnt. Further, it will be discussed whether typical gestures (analogous to biologically primary skills) and atypical gestures (analogous to biologically secondary skills) can both be produced by humans, and whether the two types of gestures may have differential impacts on learning.

The Evolutionary Significance of Gestures

It has been hypothesised that the words and sentences of early languages likely evolved from both deictic and iconic gestures, suggesting that gestures may bear evolutionary significance (Arbib et al., 2008; Armstrong, Stokoe, & Wilcox, 1995). If language did indeed evolve from gesture, it may be that the performance of gesture evolved as a source of human communication (Arbib et al., 2008; McNeill, 2000). Research has suggested that observing iconic gestures performed by a speaker, such as a mother, can improve both native and foreign language acquisition (Macedonia, Müller, & Friederici, 2011). However, while the benefits that observed gestures have for language acquisition suggest that observing iconic hand gestures may aid learning, the story is more complicated than simply stating that observing gestures aids "learning." Not all learning is equal: some skills are innate (biologically primary skills, such as native language learning), whereas others require academic learning (biologically secondary skills, such as foreign language learning by adults). Whether a skill is innate or learnt could potentially have a differential impact on how easily it is learnt.

Biologically Primary and Secondary Skills

Biologically primary skills are innate competencies that serve an important evolutionary function for survival, reproduction, or growth, such as speaking one's native language, or the ability to recognise faces (Geary, 2002; Geary & Lin, 1998). These skills are the result of evolution over thousands of generations, and are acquired easily without conscious effort or formal instruction (J. Sweller, 2009). Furthermore, biologically primary skills are learnt in a self-motivated manner (Geary, 2008). That is, a child is typically self-motivated to develop and utilise the ability to speak their native language. Simply being immersed in a functioning society is enough for a child to pick up the biologically primary skill of listening to and speaking their native language.

In comparison, biologically secondary skills are competencies that most commonly emerge with formal academic learning and as a result are typically not found in unschooled populations, including reading, writing, and the ability to speak a foreign language (Geary and Lin, 1998; Macedonia et al., 2011). In contrast to biologically primary skills, biologically secondary skills require conscious effort, external motivation, and formal instruction to acquire. For example, it is unlikely that the ability to understand algebra (a biologically secondary skill) would be observed in the absence of formal activities designed to foster the development of that skill (Geary & Lin, 1998). This difficulty in acquiring biologically secondary skills may arise because these skills have only recently become culturally relevant, and as a consequence, not enough time has elapsed for evolution to allow us to acquire these skills as easily as we acquire those that are biologically primary (J. Sweller, 2009). For example, a child typically acquires the biologically primary skill of listening more easily than the biologically secondary skill of reading.

In addition, biologically primary skills may play a role in the acquisition of biologically secondary skills (Paas & J. Sweller, 2012). For example, it is thought that the biologically secondary skills of both reading and writing emerged from the motivation to communicate with one other (i.e., from the biologically primary skills of listening to and speaking a native language) and from other biologically primary skills such as visual scanning (i.e., the direction of attention to the surrounding environment; Geary, 2002; Koenig, 1998). However, biologically primary skills such as language are not sufficient in and of themselves for the development of biologically secondary skills (Geary, 2002). The inability of biologically primary skills to give rise to biologically secondary skills may occur due to the remoteness of cognitive functions underlying the acquisition of biologically secondary skills from the evolved cognitive functions of related biologically primary skills (Geary & Bjorklund, 2000). As a result, just because an individual is able to speak their native language (a biologically primary skill), it does not automatically mean that they are able to read or write (two biologically secondary skills related to language acquisition), without being explicitly taught those skills. Although biologically primary skills may aid in the acquisition of biologically secondary skills, it is not automatic that mastering one will lead to the other. Other factors may be at play, such as the working memory capacity of the learner.

The Role of Gesture in Biologically Primary and Biologically Secondary Skills

Working memory restrictions play a critical role in the acquisition of biologically secondary skills, and through decreasing the load placed on working memory, gesture may help to foster the development of these culturally relevant skills (Paas & J. Sweller, 2012). For example, Marcus, Cleary, Wong, and Ayres (2013) suggested that observing hand movements (a biologically primary skill) could indeed support the acquisition of learning how to tie knots (a biologically secondary skill).

However, the beneficial effects of gesture may not just be limited to the acquisition of biologically secondary skills. Through helping to construct complex understanding from simple verbal explanations, gesture may play a beneficial role in the acquisition of biologically primary skills such as speech comprehension and basic problem solving abilities (Chu & Kita, 2011; Kelly, Barr, Church, & Lynch, 1999; Paas & J. Sweller, 2012). The use of gesture benefits the biologically primary skill of comprehension through decreasing the load placed on working memory (Paas & J. Sweller, 2012). That is, the use of gesture and speech together imposes a lower working memory load than does the use of speech only, thus promoting learning. While gesture has been shown to benefit learning when combined with speech, no research to date has investigated whether some gestures are in fact analogous to biologically primary and biologically secondary skills. Just as not all learning is equal (i.e., biologically primary skills are learnt more easily than biologically secondary skills), it may be that some gestures (i.e., those analogous to biologically primary skills) promote learning to a greater extent than other gestures (i.e., those analogous to biologically secondary skills).

Humans, among other primates, have evolved the ability to decode and imitate an observed gesture (Hewes, 1973). For a long time, learning how to make tools depended not on speech, but on the careful observation and imitation of gestures (Hewes, 1973). Even now, we rely primarily on observing one's actions as opposed to their spoken word to learn how to make tools, some weapons, and even play the violin or partake in archery (Hewes, 1973). Interestingly, some gestures acquired by non-human primates are genetically pre-determined and are thus innate, such as the chest beat performed by gorillas, while some are idiosyncratic gestures that are not the result of a genetic predisposition (Arbib et al., 2008). These idiosyncratic, novel gestures are learnt through a process called ontogenetic ritualisation (Tomasello & Call, 1997). The process of ontogenetic ritualisation refers to an individual learning a unique gesture through regular, repeated dyadic social interactions until eventually it becomes integrated into their gestural repertoire (Arbib et al., 2008; Halina, Rossano, & Tomasello, 2013). For example, a young bonobo might approach another young bonobo and raise his arm in preparation to play-hit the other, and then actually begin play. Over repeated instances, the recipient young bonobo learns to associate the arm raise as preparation for play, and so begins play once the initial arm raise gesture has been observed. Eventually, the recipient young bonobo will too learn to perform the arm-raise gesture to initiate play with another young bonobo. At this point, the arm-raise gesture has become integrated into the young bonobo's gestural repertoire, and thus, a gesture that was not once a communicative signal becomes communicative over a period of time (Arbib et al., 2008).

It can be argued that the innate gestures produced, such as the chest beat seen in gorillas, are analogous to biologically primary skills, as they are genetically predetermined and important for communication. In contrast, it may be that the gestures learnt through ontogenetic ritualisation, such as the arm-raise to initiate play as seen in young bonobos, are analogous to a biologically secondary skill, as they require instruction to become a part of one's gestural repertoire. While gestures that are arguably biologically primary or secondary are yet to be established empirically among humans, it is possible that gestures produced frequently by humans (i.e., typical gestures) could be analogous to biologically primary skills. In contrast, gestures that could be produced, for example while telling a story, but typically are not (i.e., atypical gestures) could be analogous to biologically secondary skills. If typical gestures are indeed analogous to biologically primary skills, and if atypical gestures are analogous to biologically secondary skills, it may be that typical gestures are more beneficial to learning than atypical gestures.

The ability to learn from a narrative is itself a biologically primary skill, as children from as young as 4-years old engage in basic narrative comprehension processes before formal instruction occurs at school (Lynch et al., 2008). However, not all narratives are equal in complexity and as a result some narratives may be harder to learn from than others. If typical gestures are indeed analogous to a biologically primary skill, then a narrative accompanied by typical gestures may itself be processed through the biologically primary system and thus be easier to learn. Comparatively, if atypical gestures are analogous to a biologically secondary skill, then a narrative accompanied by atypical gestures may itself be processed through the biologically secondary system and thus be harder to learn than a narrative containing typical gestures. In this way, it may be that viewing a narrative with typical gestures may benefit learning to a greater extent than viewing a narrative with atypical gestures.

In order to compare the effects of typical versus atypical gestures accompanying a narrative, a classification of individual gestures as either typical or atypical is required. It may be possible to split gestures into typical versus atypical by watching the gestures spontaneously made by speakers while themselves telling a narrative. One study by N. Sweller and Dargue (2013) investigated the types of iconic gestures typically performed by individuals while retelling a narrative. Participants, including both preschool children and adults, were presented with a cartoon about Donald Duck trying to refill a watering can to water his prized watermelons. After watching the cartoon, participants retold the narrative to the experimenter, who then coded the gestures that participants performed.

For the purpose of this thesis, gestures that were frequently performed by participants in the study by N. Sweller and Dargue (2013) are termed typical gestures; such as a participant moving their hands up and down while saying “Donald Duck pumped the lever.” These gestures were not artificially elicited in the 2013 study, but were rather spontaneously performed by the participants. In this way, they are likely to be close in nature to biologically primary, typical gestures. Conversely, gestures that were not performed by participants in the study by N. Sweller and Dargue, but which could have been used to signify an event in the cartoon are termed atypical gestures. For example, a participant pointing up and then down quickly while saying “Donald Duck pumped the lever” could represent the movement associated with a pumping motion. In other words, both the typical and atypical gestures could both be used to represent the same point in the narrative. However, the typical gestures were ones that participants previously spontaneously produced, whereas the atypical ones were created specifically for the current study and were designed to be visually different in nature from any of the spontaneously produced, typical gestures. These two types of gestures may have differential impacts on learning.

Present Study

Considering the apparent link between gesture and learning, the current study aimed to explore whether iconic other-oriented biologically primary gestures (i.e., typical gestures) and iconic biologically secondary gestures (i.e., atypical gestures) affect narrative comprehension in an adult population. Furthermore, the current study also aimed to distinguish whether gestures are of greater benefit to narrative comprehension when a narrative presents complex information than when it presents simple information. As the ability of self-oriented gestures to benefit narrative comprehension has also been under-researched, the current study further aimed to determine whether the production of self-oriented gestures is of benefit to narrative comprehension in adults, again in regards to both typical and atypical gestures.

These aims were examined using a visual narrative told orally in one of three conditions: with typical gestures, with atypical gestures, or with no accompanying gestures (control). Within each of these three conditions, the narrator spoke a series of complex words at certain points throughout the narrative, and these alternated with simple words spoken at different points (counterbalanced) throughout the narrative. Participants' recall was measured through both free recall and specific follow-up questions, which covered both points in the narrative with accompanying gestures and points in the narrative with no accompanying gestures. The follow-up questions also covered both simple and complex word points throughout the visual narrative. Follow-up questions covering simple and complex points both with and without gesture were required as participants frequently report very little information through free recall. A full comparison of the effects of both the gestures and of word complexity requires responses on sufficient numbers of points that relate to each of these aspects of the study design. It should be noted that observing the other-oriented gestures is only expected to be of benefit to the free recall of the visual narrative (assuming participants report points that relate to gestures) and to specific questions that addressed points that had accompanying gestures in the visual narrative. It is not expected that the presence of gesture in the narrative will be of benefit to follow-up questions that addressed points that were not accompanied by gestures in the visual narrative.

The gestures produced by participants during free recall when retelling the narrative were coded as typical (gestures that mirrored those produced by the narrator in the typical gesture condition), atypical (gestures that mirrored those produced by the narrator in the atypical condition), or other (gestures that were not produced by the narrator) to examine whether the number of self-oriented gestures produced predicts narrative comprehension. Coding the gestures that participants produced as typical, atypical, or other allowed the investigation of whether the production of typical, atypical, and other gestures predict narrative comprehension on their own. Due to the brevity of the responses for specific follow-up questions, and the associated scarcity of gestures produced when producing potentially single-word responses, the beneficial effects of participants' own spontaneously produced gestures were only expected for free recall of the narrative.

The following research questions are therefore the focus of the current study:

1. Do typical gestures aid narrative comprehension to a greater extent than atypical gestures?
2. Does observing gesture benefit narrative comprehension to a greater extent when the narrative is complex than when the narrative is simple?
3. Does the self-oriented production of gesture during free recall of a narrative assist narrative comprehension?

Hypotheses

For both free recall and for specific follow-up questions relating to gesture points in the narrative:

H1. Averaged across simple and complex points, a main effect of gesture condition is expected such that:

(a) Performance will be better in both gesture conditions compared with the control condition.

(b) Participants in the typical gesture condition will perform better than participants in the atypical gesture condition.

H2. Averaged across gesture condition, it is expected that participants will recall simple points from the narrative significantly better than complex points from the narrative.

H3. An interaction is expected, such that the difference between the recall of simple and complex points in the narrative is expected to be smaller for the gesture conditions than for the control condition, and smaller again for the typical gesture condition than for the atypical gesture condition.

Conversely, for free recall and follow-up questions relating to non-gesture points in the narrative, as well as free recall of non-manipulated points in the narrative, no effects of gesture condition are expected.

It is further expected that:

H4. Participants who produce a greater number of gestures will have greater free recall, such that the number of gestures produced will positively predict free recall scores, beyond the number of words spoken.

Pilot Study

A pilot study was undertaken to establish whether the gestures produced by the narrator were appropriate, and whether the interview questions that related to the narrative were adequately understood across all three conditions. In particular, any comments made by participants about the gestures produced in the atypical gesture condition were of interest, to determine whether participants thought the gestures were particularly incongruous. Participants included 12 students (7 females and 5 males) aged between 17 years and 8 months and 26 years and 8 months (*M* = 20.29, *SD* = 2.58) recruited from introductory and cognitive psychology courses at Macquarie University. After consent was obtained, participants were randomly assigned to the typical gesture, atypical gesture, or control (no gesture) condition. The procedure of the study was followed as described below. Examination of pilot data gave no indication of problematic floor or ceiling performance, or of any problematic gestures or interview questions. Participants from the pilot study were therefore included in the final study as no changes were made to either the stimuli used or to the procedure of the study.

Method

Ethics Approval and Participants

Ethics approval was obtained from the Macquarie University Human Research Ethics Committee (Reference Code: 5201500047) prior to commencement of the study. One hundred and thirty students were recruited from introductory and cognitive psychology courses at Macquarie University via advertisement (see Appendix A for advertisement) on the Macquarie University Psychology Participant Pool. The introductory psychology group consisted of 39 students (35 females and 4 males), ranging from 17 years and 8 months to 42 years and 10 months (*M* = 19.66, *SD* = 4.02). The cognitive psychology group consisted of 91 students (66 females and 25 males), ranging from 18 years and 8 months to 52 years and 5 months (*M* = 22.28, *SD* = 7.03).

Experimental Design

The present study was a 3 x (2) mixed design, with gesture condition (typical/atypical/control) as the between-subjects factor and word complexity (simple/complex) as the within-subjects factor. A within-subjects design was chosen for word complexity because a within-subjects design can be more powerful than a between-subjects design due to the removal of variance caused by between-subjects differences from the error variance. Furthermore, as word complexity could be counterbalanced easily between participants, differences in question difficulty between the specific follow-up questions would not be of concern. However, gesture condition was chosen as a between-subjects factor as insufficient typical gestures were identified in N. Sweller and Dargue (2013) to allow typical and atypical gestures to be counterbalanced between participants in a within-subjects design.

Participants were randomly allocated to one of three conditions: typical gesture, atypical gesture, or control. The typical gesture condition included 44 students (34 females and 10 males), ranging from 17 years and 11 months to 52 years and 5 months (M = 20.54, SD = 5.23). The atypical gesture condition included 44 students (34 females and 10 males), ranging from 17 years and 11 months to 51 years and 8 months (M = 23.11, SD = 8.00). The control condition included 42 students (33 females and 9 males), ranging from 17 years and 8 months to 44 years (M = 20.80, SD = 5.29). Recall of the narrative content through both free recall and specific questions were the key dependent variables of interest, with higher scores indicating greater narrative comprehension.

Materials

Peabody Picture Vocabulary Test. The Peabody Picture Vocabulary Test-4 Form B (PPVT-4; Dunn & Dunn, 2007) was used as a measure of participants' receptive language vocabulary, an important component of comprehension (Joshi, 2005). As comprehension was of interest to the study, the use of the PPVT-4 was required to determine whether participants had adequate English language skills to understand the visual narrative. A total of 45 participants had a receptive language vocabulary level below 18 years of age, ranging from between 10 years and 1 month to 17 and 11 months (the remaining 85 participants received scores above 18 years of age). The initial intention was to remove participants with a receptive language vocabulary level below 18 years of age from the current study, as their comprehension would not be adequately representative of the adult population. However, as removal would have required the elimination of 34.6% of the total sample from the experiment, final analyses were completed both with and without the participants with a receptive language vocabulary level below 18 years of age. Removing the participants with a receptive language vocabulary level below 18 years of age did not alter the pattern of results. Therefore, all participants were retained in the sample for final analyses (See Appendix B for analyses excluding participants with receptive language levels below 18 years of age). The PPVT-4 is a reliable and valid measure of receptive vocabulary, with a reported internal consistency of .94, test-retest reliability of .93, alternate-forms reliability of .89, and convergent validity ranging from .68 to .82 (Dunn & Dunn, 2007).

Video Stimulus. The primary stimulus was a 2-minute visual narrative, based on an existing cartoon in which Donald Duck had difficulty refilling a watering can to water his prize-winning watermelon garden. The narrative was told by an adult female unknown to participants and was recorded using a video camera. To reduce variability and the potential for participants to become distracted, the narrator was dressed in the same clothes with the same hairstyle against a plain white wall when filming all three conditions.

In the typical gesture condition the narrator produced a series of typical iconic gestures at specific points throughout the narrative (only commonly used gestures, e.g., holding up one finger to represent first prize). These gestures were determined based on gestures produced by participants in a previous study conducted by N. Sweller and Dargue (2013). N. Sweller and Dargue showed participants the original 3-minute long Donald Duck cartoon and coded the gestures that participants spontaneously produced while answering recall questions about the cartoon. As noted above, participants were given no explicit instructions regarding gesture production, meaning that all gestures produced were naturally occurring. For the purpose of the current study, typical gestures are those that were produced most frequently by participants at recall in the study by N. Sweller and Dargue. To determine those gestures that were the most frequently produced, the gestures that participants made at recall in the study by N. Sweller and Dargue were coded and then placed into a category. For example, if a participant made two fists with their hands and moved them up and down simultaneously while verbally describing Donald Duck pumping, the gesture produced was categorised as a “pumping gesture.” As different participants made different kinds of gestures to represent certain points, the most frequently produced gesture for each gesture point was used in the current study. For example, some participants made a pumping gesture with only one hand instead of two, but as more participants produced the pumping gesture with two hands in the 2013 study, the pumping gesture with two hands was selected for use in the current study. As a result, the 10 most frequently produced gestures were chosen for use in the current study, and were performed by the narrator.

In contrast, in the atypical gesture condition the narrator produced a series of atypical iconic gestures at specific points throughout the narrative (gestures which are not commonly produced, e.g., making the shape of a circular rosette ribbon with your hands and holding it up to represent first prize). These gestures were never produced by participants in N. Sweller and Dargue’s (2013) study, but could have been produced in response to watching the narrative. In other words, these were gestures that accurately reflected the speech content of the narrative, but were at no point produced spontaneously by participants in N. Sweller and Dargue’s study. Gestures were presented by the narrator at the same point in the narrative for both the typical and atypical gesture conditions; the only difference between the two conditions was in the nature of the gestures produced. That is, in each condition a total of 10 gestures were produced at specific points in the narrative. If the participant was in the typical condition, they viewed 10 typical gestures in the narrative. If the participant was in the atypical condition, the gestures viewed were atypical. Participants in the control condition saw no gestures, and the narrator kept a still body.

The narrative contained 10 phrases that were accompanied by the “gesture points” described above, and six phrases that were not accompanied by gestures (termed “non-gesture points”; see Appendix C for gesture and non-gesture points). For example, the narrator gestured on the phrase “water began spurting out straight into Donald Duck’s eye” but did not gesture on the phrase “Donald Duck had a garden full of watermelons.” In addition, the narrative contained 47 non-manipulated phrases that were not manipulated for either complexity or gesture. These phrases served as a filler to ensure that the narrative flowed smoothly. In total, the narrative contained 63 phrases (see Appendix D for total phrases).

Each gesture and non-gesture point contained either a simple or complex word, manipulated within-subjects. Simple words were those that are frequently spoken in the English language (e.g., nostrils), while complex words were those that are infrequently spoken in the English language (e.g., nares), as determined by the English Lexicon Project (http://elexicon.wustl.edu). Complex words had frequency ratings that were at least half those of the paired simple word. For example, the simple word “broke” had an associated frequency rating of 14085, while the complex word “disunited,” while having the same meaning as the simple word broke, had an associated frequency rating of 36.

The 16 manipulated points were split into eight simple and eight complex phrases. Of these 16 phrases, five simple and five complex words related to the gesture points, while three simple and three complex words related to the non-gesture points.

The phrases which contained simple vs. complex words presented in the narrative were counterbalanced within each gesture condition, meaning two different video recordings were required for each of the three conditions (total of six video recordings; see Appendix E for table of counterbalanced simple and complex words). For example, the phrase “water began spurting out straight into Donald Duck’s eye” contained the simple word “eye” for one participant. In contrast, the phrase “water began spurting out straight into Donald Duck’s oculus” contained the complex word “oculus” for another participant, counterbalancing the simple and complex words between participants. Gestures were performed on the same words in all gesture conditions, with gesture and non-gesture points kept the same across conditions.

Filler Task. After watching the visual narrative, participants completed a join-the-dots filler task (see Appendix F for filler task). This ensured that participants would not perform at ceiling level, by providing a break between watching the narrative and subsequent recall. Participants were given a maximum of 120 seconds to complete the filler task.

Response Items. Participants were asked one free recall question followed by 16 specific follow-up questions that related to the 16 manipulated points noted above (see Appendix G for interview script). Five of the questions related to simple gesture points, five of the questions related to complex gesture points, three of the questions related to simple non-gesture points, and three of the questions related to complex non-gesture points. Questions about the non-gesture points in the narrative assessed participants' comprehension of general information that was relayed in the narrative. Questions about the gesture points in the narrative assessed both the comprehension of gestured information and the effect of the gesture manipulations. The specific follow-up questions were asked in a pre-determined random order, as formulated by a random number generator (https://www.randomizer.org/form.htm). The random order differed for each participant.

Each specific question included an open-ended question (e.g., "Where did the water push Donald Duck?") and a forced-choice follow up question (e.g., "Did the water push Donald Duck down to the ground or up into the sky?"). The follow-up question followed the open-ended question, but was only asked if the participant gave an incorrect response, responded ambiguously, or did not respond to the open-ended question. In contrast, if the participant answered the open-ended question correctly, the follow-up question was not asked. For example, if a participant answered with an incorrect response, such as "Off to the side" to "Where did the water push Donald Duck?" then the follow-up question "Did the water push Donald Duck down to the ground or up into the sky?" was asked. In comparison, if a participant answered with a correct response, such as "Up into the sky" in response to

"Where did the water push Donald Duck?" then the follow-up question was not asked. The process for coding and scoring the interview questions is described below.

Two question sets were produced to counterbalance the order of the forced-choice response options, to reduce the likelihood of order-effects occurring. For example, in the first set the options were phrased "Was Donald Duck pushed down to the ground or up into the sky?" whereas in the second set the options were phrased "Was Donald Duck pushed up into the sky or down to the ground?" These two question sets were counterbalanced between participants.

Recording Device. Participants' responses were video-recorded to allow for the recording of gestures that participants produced at recall, and to allow coding to be completed at a later point in time. Prior to the video camera being turned on, participants were informed that the video recordings were confidential and necessary to code their responses at a later point. Before recording began, verbal consent was attained from all participants. All participants in the study agreed to the recording.

Procedure

Participants were informed that the study was about narrative comprehension and signed an information and consent form prior to participating in the study (see Appendix H for information and consent form). All participants were seen within a quiet room at Macquarie University for between 20 and 30 minutes. Participants initially sat and spoke of themselves for one to two minutes with the experimenter to establish rapport. The experimenter then explained the tasks that the participant would complete, and informed them that they would be granted course credit for their participation.

Participants were each randomly allocated to a condition before the session commenced. Once allocated to a condition, the participant and experimenter together viewed the visual narrative that corresponded to the participant's assigned condition on a laptop computer. After participants finished watching the narrative they were presented with the join-the-dots filler task. After completing the filler task, the recording device was shown to participants and the experimenter stated “Now I am going to ask you some questions, do you mind if I turn the video camera on so that I can remember what you say later?” This question was asked in order to obtain the verbal consent of all participants to have their verbal and gestural responses recorded.

Once verbal consent had been obtained, the video camera was turned on. The experimenter then stated “Now I am going to ask you some questions about the video that you saw on the computer earlier. If you do not know the answers you can just guess, ok? First, tell me everything that you can remember about the story that you saw earlier.” The free recall question always preceded the specific recall questions, to ensure that the content of the specific recall questions did not prompt the participant to recall certain aspects of the narrative during free recall. After the free recall question had been answered, the experimenter stated “Now I am going to ask you a few more questions about the story that you saw earlier. The questions I am going to ask will not necessarily be in the same order as what you saw in the video.”

The specific recall questions were then asked. If a participant answered a specific recall question incorrectly, a forced-choice follow up question was then asked. If the participant appeared distracted or confused the question was repeated, and if they were unsure of the answer participants were reminded that it was ok to take a guess. After all questions had been asked, the video camera was turned off. The PPVT-4 was then produced by the experimenter, who then told participants that it was a test of receptive language in which they were to point to the correct picture that corresponded to a word they were told. Prior to starting the test, the training pages of the PPVT-4 were completed by participants to ensure that the procedure as outlined in the PPVT-4 manual was accurately followed. The PPVT-4 scoring sheet was kept out of participants' sight during the administration of the test to ensure that responses were discretely recorded. Non-directional feedback was given throughout the administration of the test such as "I can see how hard you're trying" and "Thank you," regardless of the accuracy of the answers.

After the PPVT-4 had been completed, all participants were asked what they thought the study was about to check whether participants were aware that the focus of the study was related to gestures. After briefly explaining to the experimenter what they thought the purpose of the study was, participants were granted course credit and thanked for their time. Cognitive psychology students were also given a half-page summary of how the study related to cognition, as requested by the convener of their course (see Appendix I for study summary).

Manipulation Check

To sort the responses that participants gave when they were asked what the study was about, two categories were created: gesture and other. Of the 130 participants, seven correctly suggested that the primary aim of the current study involved gesture. Of these seven participants, three were from the typical gesture condition, while four were from the atypical gesture condition, accounting for 5% of the total sample. The majority of participants (95%) suggested that the primary aim of the current study concerned variables other than gesture, such as comprehension or memory. The very similar number of participants who correctly guessed that the study was about gesture from the typical and atypical conditions should be noted: if the atypical gestures were inappropriate for their accompanying phrases, or stood out as being in some way odd, more participants would have been expected to comment on the gestures at this point in the study.

Transcribing and Coding

Prior to coding, all speech and gesture content of the interviews was transcribed. Participant responses that correctly represented the speech content of the narrative were coded as correct. Participant responses that did not correctly represent the speech content of the narrative, as well as non-responses to specific questions were coded as incorrect. Correct and incorrect responses were split into categories. For free recall, correct and incorrect responses were sorted into the following five categories: simple gesture points, complex gesture points, simple non-gesture points, complex non-gesture points, and non-manipulated points. A correct response during free recall was given a score of 1, with the maximum score being 63, based on the 63 phrases in the narrative. The categories for specific questions mirrored those for free recall, with the exception that there were no specific questions on non-manipulated points from the narrative.

The gestures that participants produced were used in one of two ways. For free recall they did not contribute to the free recall score, but were coded as described below. However, for recall of specific questions, gestures contributed to the total recall score, together with any verbal response.

Gestures produced by all participants during free recall were coded as typical, atypical, or other, for the purposes of entering the number of gestures produced as predictors into regressions predicting verbal recall (Hypothesis 4). Gestures produced during free recall that mirrored the typical gestures that were presented to participants in the visual narrative within the typical gesture condition were coded as typical. In contrast, gestures that mirrored the atypical gestures that were presented to participants in the visual narrative within the atypical gesture condition were coded as atypical. Gestures produced by participants that did not represent a typical or atypical gesture as previously seen in the narrative (e.g., a beat gesture) were coded as other. This coding was performed regardless of which condition a participant was assigned to. In other words, a participant in the typical gesture condition for example may still have had a gesture coded as atypical if they performed one of these gestures.

The gestures produced during the specific follow-up questions were not coded as typical, atypical, or other, as the gestures made were coded for meaning (i.e., whether the gesture represented the correct answer to a specific question) and were thus included as a dependent, rather than independent, variable. If a participant verbally answered the initial open-ended question correctly they received a score of 2 and the follow-up forced-choice question was not asked. If the participant did not accurately answer the open-ended question verbally but represented the correct response through the use of gesture (e.g., if the participant stated that Donald Duck used a lever to get more water but performed a pumping gesture with their hands) they also received a score of 2 and the follow-up question was not asked. Similarly, if the participant answered the open-ended question accurately both verbally and through gesture they received a score of 2. If a participant incorrectly answered the open-ended question, then the follow-up forced-choice question was asked. If the follow-up forced-choice question was answered correctly verbally, through the use of gesture, or through a combination of speech and gesture, the participant received a score of 1. If both the open-ended and follow-up forced-choice question were answered incorrectly, the participant received a score of zero for that particular question.

As each question was scored out of 2, participants could receive a maximum score of 10 for simple gesture points, 10 for complex gesture points, 6 for simple non-gesture points, and 6 for complex non-gesture points. Although ideally the gestures produced during free recall would also have been coded for meaning in a manner similar to those accompanying the specific questions, this procedure would preclude the gestures being used as predictors to assess Hypothesis 4 above, as the same information produced cannot be used as both a dependent and independent variable.

Reliability

A second coder independently coded 20% of the total transcripts in order to assess inter-rater reliability for all verbal and gestural responses. Intra-class correlations (ICC) were obtained to evaluate reliability using an absolute agreement model. The single measure ICC is reported, as only the first coder's scores were used in the final analyses. For free recall, ICC = .92, $p < .0005$, and for the specific follow-up questions, ICC = .98, $p < .0005$. Finally, for the number of gestures produced, ICC = .84, $p < .0005$.

Analysis Plan

Preliminary Analysis. Prior to data analysis, the distributions of dependent variables were checked. All variables of interest were normally distributed, with skewness values between ±1 and no notable outliers.

Final Analysis. Using SPSS (version 21.0), Analyses of Variance (ANOVAs) were conducted using the general linear model (GLM) procedure, to test main effects and interactions of gesture condition and word complexity on narrative comprehension. Linear regression analyses were used to test whether the spontaneous production of gesture at recall predicts narrative comprehension. For all statistical analyses that required multiple follow-up comparisons, the alpha level was Bonferroni adjusted to control the Family-wise error rate at .05.

Results

The Effect of Gesture Condition and Word Complexity on Free Recall of the Gesture Points

The effect of gesture condition and word complexity on comprehension of the narrative was examined for free recall of the gesture points. A 3 (condition) x (2) (word complexity) mixed design ANOVA was carried out, with total score on free recall of gesture points as the dependent variable. Gesture condition was a between-subjects factor, while word complexity was a within-subjects factor. Averaged across word complexity, there was a main effect of gesture condition, $F(2, 127) = 4.11$, $p = .019$, *partial* $\eta^2 = .06$. Free recall was significantly higher for the typical gesture condition than for the control condition, $F(2, 127) = 8.18$, $p = .005$, *partial* $\eta^2 = .06$. However, there was no significant difference between the typical and the atypical gesture condition, $F(2, 127) = 1.63$, $p = .203$, *partial* $\eta^2 = .01$, or between the control condition and the atypical gesture condition, $F(2, 127) = 2.55$, $p = .112$, *partial* $\eta^2 = .02$.

Averaged across gesture condition, the results showed a main effect of word complexity, $F(1, 127) = 4.55$, $p = .035$, *partial* $\eta^2 = .04$, such that participants performed significantly better when recalling simple points from the narrative than when recalling complex points from the narrative. No interaction was found between gesture condition and word complexity, $F(2, 127) = .537$, $p = .586$, *partial* $\eta^2 = .01$ (see Table 1).

Table 1

Simple and Complex Mean (and Standard Deviation) Free Recall Scores on Gesture Points by Condition

	Condition		
Word Complexity	Typical	Atypical	Control
Simple	1.68 (1.22)	1.32 (1.05)	1.14 (1.10)
Complex	1.30 (.95)	1.23 (1.03)	.86 (.87)

Note. Standard Deviations appear in parentheses.

The Effect of Gesture Condition and Word Complexity on Free Recall of the Non-Gesture Points

The effect of gesture condition and word complexity on free recall of non-gesture points was examined using a 3 (condition) x (2) (word complexity) mixed design ANOVA with free recall of non-gesture points as the dependent variable. There was no main effect of gesture condition when averaged across word complexity, $F(2, 127) = .385$, $p = .681$, *partial* $\eta^2 = .01$, or of word complexity when averaged across gesture condition, $F(1, 127) = 2.005$, $p = .159$, *partial* $\eta^2 = .02$. No interaction was found between gesture condition and word complexity, $F(2, 127) = .132$, $p = .877$, *partial* $\eta^2 < .0005$ (see Table 2).

Table 2

Simple and Complex Mean (and Standard Deviation) Free Recall Scores on Non-Gesture Points by Condition

	Condition		
Word Complexity	Typical	Atypical	Control
Simple	.43 (.59)	.55 (.66)	.48 (.59)
Complex	.39 (.58)	.43(.63)	.36 (.53)

Note. Standard Deviations appear in parentheses.

The Effect of Gesture Condition on Free Recall of the Non-Manipulated Points

The effect of gesture condition on the number of non-manipulated points participants recalled during the free recall task was examined using a one-way between-subjects ANOVA, with gesture condition as the between-subjects variable. No significant difference was found on the number of non-manipulated points recalled during free recall between gesture conditions, $F(2, 127) = .34$, $p = .710$, *partial* $\eta^2 = .01$, indicating that the observation of gesture did not significantly increase the number of non-manipulated points recalled by participants during free recall of the narrative (Typical $M = 6.59$, $SD = 2.77$; Atypical $M = 6.05$, $SD = 3.36$; Control $M = 6.33$, $SD = 3.11$).

The Effect of Gesture Condition and Word Complexity on Specific Questions Relating to Gesture Points

The effect of gesture condition and word complexity on comprehension of gesture points was examined for the specific questions that related to gesture points in the narrative.

A 3 (condition) x (2) (word complexity) mixed design ANOVA was carried out, with total score on questions relating to gesture points as the dependent variable. Gesture condition was a between-subjects factor, while word complexity was a within-subjects factor. Averaged across word complexity, there was a main effect of gesture condition, $F(2, 127) = 8.84$, $p < .0005$, *partial* $\eta^2 = .12$. Recall on gesture points was significantly higher for the typical gesture condition than for both the control condition, $F(2, 127) = 13.79$, $p < .0005$, *partial* $\eta^2 = .18$, and the atypical gesture condition, $F(2, 127) = 12.67$, $p = .001$, *partial* $\eta^2 = .17$. There was no significant difference on recall between the control condition and the atypical gesture condition. $F(2, 127) = .04$, $p = .850$, *partial* $\eta^2 < .0005$.

Averaged across condition, the results showed a main effect of word complexity, $F(1, 127) = 5.55$, $p = .020$, *partial* $\eta^2 = .04$, such that participants performed significantly better when recalling simple points from the narrative than when recalling complex points from the narrative. No interaction was found between word complexity and gesture condition, $F(2, 127) = 2.05$, $p = .133$, *partial* $\eta^2 = .03$ (see Table 3).

Table 3

Simple and Complex Mean (and Standard Deviation) Gesture Point Scores by Condition

		Condition	
Word Complexity	Typical	Atypical	Control
Simple	6.95 (1.99)	5.95 (1.93)	6.43 (2.07)
Complex	6.77 (1.96)	5.66 (2.13)	5.07 (2.10)

Note. Standard Deviations appear in parentheses.

The Effect of Gesture Condition and Word Complexity on Specific Questions Relating to Non-Gesture Points

The effect of gesture condition and word complexity on specific questions corresponding to non-gesture points was examined using a 3 (condition) x (2) (word complexity) mixed-design ANOVA with total score on non-gesture points as the dependent variable. There was no main effect of gesture condition averaged across word complexity, $F(2, 127) = 1.17$, $p = .313$, *partial* $\eta^2 = .018$, or word complexity when averaged across gesture condition, $F(1, 127) = .91$, $p = .342$, *partial* $\eta^2 = .007$. No interaction was found between word complexity and gesture condition, $F(2, 127) = 1.73$, $p = .182$, *partial* $\eta^2 = .03$ (see Table 4).

Table 4

Simple and Complex Mean (and Standard Deviation) Non-Gesture Point Scores by Condition

	Condition		
Word Complexity	Typical	Atypical	Control
Simple	3.41 (1.02)	2.95 (1.36)	3.45 (1.09)
Complex	3.05 (.99)	3.16 (1.35)	3.24 (1.03)

Note. Standard Deviations appear in parentheses.

The Production of Spontaneous Gesture on Free Recall

Multiple linear regression analyses were undertaken to test whether the number of gestures performed at recall significantly predicted participants' free recall beyond the number of words spoken. A correlation between the total number of gestures performed and performance on free recall would not be sufficient to address whether performing a greater number of gestures predicts greater recall. The greater number of gestures performed and higher scores on free recall could both be attributed to the number of words spoken by each participant, which could all reflect the time spent on the task. Therefore, the number of words spoken by the participant was held constant when investigating whether the number of gestures produced predicted performance on the free recall task. Total scores on free recall were created for this analysis by summing the five categories used to code free recall responses. These five categories included simple gesture points, complex gesture points, simple non-gesture points, complex non-gesture points, and non-manipulated points.

A series of regression analyses regressed free recall performance on the three distinct types of gestures produced separately: typical gestures produced, atypical gestures produced, and other gestures produced during free recall. The number of typical gestures produced and the total number of words spoken together explained 71% of the variance in free recall performance, $R^2 = .71$; $F(2, 127) = 152.86$, $p = < .0005$. Both the number of typical gestures produced ($\beta = .51$, $p = .001$) and the total number of words spoken ($\beta = .05$, $p < .0005$) significantly predicted free recall, indicating that the number of typical gestures produced significantly affected free recall beyond the total number of words spoken (see Table 5 for descriptive statistics). As it is possible that the number of typical gestures produced and the number of words spoken could be strongly related to each other, collinearity between these two variables is possibly of concern. Tolerance and the Variance Inflation Factor (VIF) were analysed, with tolerance = .81 and VIF = 1.24. Thus, collinearity was not of concern.

Conversely, while the number of atypical gestures produced and the total number of words spoken together explained 68% of the variance in free recall performance, $R^2 = .68$; $F(2, 127) = 134.85$, $p = < .0005$, it was only the total number of words spoken which on its own significantly predicted free recall ($\beta = .06$, $p < .0005$). The number of atypical gestures produced did not significantly predict free recall ($\beta = .56$, $p = .454$), indicating that the number of atypical gestures produced did not significantly affect free recall beyond the total number of words spoken (see Table 5). As with typical gestures produced, tolerance and the VIF were analysed to check for collinearity between atypical gestures produced and the number of words spoken, with tolerance = .98 and VIF = 1.02. As a result, collinearity was not of concern.

Finally, the number of other gestures produced and the total number of words spoken together explained 68% of the variance in free recall performance, $R^2 = .68$; $F(2, 127) = 134.44$, $p = < .0005$. While the number of words spoken significantly predicted free recall ($\beta = .06$, $p < .0005$), the number of other gestures produced did not significantly predict free recall ($\beta = .02$, $p = .585$), indicating that the number of other gestures produced did not significantly affect free recall beyond the total number of words spoken (see Table 5). Similar to both typical and atypical gestures produced, collinearity between other gestures produced and the number of words spoken was checked through analysing tolerance and VIF, with tolerance = .81 and VIF = 1.24. Thus, collinearity between other gestures produced and the number of words produced was not of concern.

Table 5

Means for Free Recall, Gestures Produced, and the Number of Words Spoken

Variable	*M*	*SD*
Free Recall	9.69	4.67
Total Words Spoken	114.64	64.73
Total Gestures Produced	7.29	6.83
Typical Gestures Produced	1.23	1.70
Atypical Gestures Produced	.08	.32
Other Gestures Produced	5.97	5.92

Discussion

The current study investigated whether observing and producing different types of iconic hand gestures affects the narrative comprehension of adults. A key area of interest was whether typical gestures benefit narrative comprehension to a greater extent than atypical gestures. The current study also examined whether observing gestures aids narrative comprehension to a greater extent when the narrative is complex compared with when the narrative is simple. Finally, the study explored whether the self-oriented production of gesture during free recall of a narrative assists narrative comprehension.

The Effect of Typical and Atypical Gestures on Narrative Comprehension

The present study predicted that both free recall and recall of specific questions relating to gesture points would be greater for both gesture conditions when compared to the control condition, and for the typical gesture condition than the atypical gesture condition. As predicted, there was a main effect of gesture condition for recall of specific questions: recall of the specific follow-up questions that related to gesture points was significantly higher for the typical gesture condition compared with both the control condition and the atypical gesture condition. For free recall, performance was significantly better for the typical gesture condition than the control condition, but there was no difference between the typical and atypical gesture conditions. Notably, performance in the atypical gesture condition did not significantly differ from the control condition for either measure of recall.

Participants learned more from typical gestures than atypical gestures, suggesting the two types of gestures are qualitatively different, with correspondingly different effects on learning. Through demonstrating that typical gestures benefit narrative comprehension to a greater extent than atypical gestures for specific questions, the current study provides evidence that typical gestures may be analogous to biologically primary skills, while atypical gestures may be analogous to biologically secondary skills. While there is much discussion of biologically primary and secondary skills in the literature (Geary, 2002; Geary, 2008; Geary & Lin, 1998) and the effect of gesture in general on biologically primary and secondary skills (Paas & J. Sweller, 2012), this is the first study to examine whether gestures exist that are analogous to biologically primary and secondary skills. Thus, through providing evidence that typical gestures may be similar to biologically primary skills, and that atypical gestures may be similar to biologically secondary skills, the current study suggests that if appropriate typical and atypical gestures can be defined, such gestures may have differential effects on other aspects of learning, such as problem solving or speech comprehension.

In contrast, there was no significant difference in recall between the atypical gesture condition and the control condition for either free recall or specific questions. This lack of a difference is particularly interesting, as it suggests that observing atypical gestures is no better than observing no gestures at all. While research has looked at the differential effects of iconic, deictic, metaphoric, and beat gestures on learning, this is the first study to investigate whether there are different subtypes of gestures within the category of iconic gestures. These proposed subtypes (i.e., typical and atypical gestures) relate to whether an iconic gesture is innate or learnt. Through showing that typical, innate gestures are beneficial to narrative comprehension and that atypical, learnt gestures are no more beneficial than no gestures at all, the current study provides evidence that there are indeed subtypes of gestures within the category of iconic gestures. These innate and learnt subtypes both differentially affect learning, with typical gestures improving narrative comprehension, and atypical gestures having little to no effect.

It has not yet been established, however, whether typical and atypical gestures are relevant only within the category of iconic gestures, or whether they may have different effects on learning in other categories of gestures, such as within metaphoric gestures. Metaphoric gestures are produced much less frequently than iconic gestures however, so it is possible that separate typical and atypical metaphoric gestures would be difficult to define. In the first instance, a preliminary investigation into whether typical and atypical gestures can be identified for non-iconic categories of gestures is required; from there, the potential communicative value of both can be tested.

It should be noted that while some effects were found for free recall, stronger effects were found for the specific follow-up questions that related to gesture points in the narrative. Scores for free recall were quite low, and while variables were normally distributed and no floor effects were observed, these low scores attained on free recall could have weakened the effect of the gesture manipulation for free recall, preventing the detection of any difference between typical and atypical gesture conditions. To boost performance in the free recall task, the experimenter could prompt participants for more information beyond the single question asked in the current study. For example, rather than just asking participants to tell the experimenter everything that they can remember from the story, participants could be asked a series of broad, non-leading questions relating to the story. For example, participants could be asked to state everything that happened in the narrative, everything that Donald Duck did, and everything Donald Duck saw before being asked if they could remember anything else from the narrative. These more detailed free recall questions have been used successfully in prior research (N. Sweller & Salmon, 2004). By summing the answers given to all these questions, free recall performance may be boosted, perhaps increasing the difference in performance between the typical and atypical gesture conditions.

As expected, no main effect of gesture condition was found for the non-gesture points in the narrative, either for free recall or for recall as measured through the specific follow-up questions. The fact that no effect of gesture condition was found for non-gesture points suggests that the main effect of gesture condition for the gesture points was indeed a result of the gestures aiding comprehension of the specific points that they accompanied in the narrative.

Recall of Simple and Complex Points Averaged Across Gesture Condition

The current study predicted that participants would recall simple points from the narrative significantly better than complex points from the narrative, regardless of the gesture condition to which they were randomly allocated. This result was predicted for both free recall and recall of specific follow-up questions.

As predicted, regardless of condition, participants performed significantly better on both free recall and the specific follow-up questions when recalling simple gesture points than when recalling complex gesture points from the narrative. Interestingly, regardless of condition, no main effect was found for word complexity when recalling non-gesture points in the narrative either for free recall or the specific follow-up questions. Even though half of the presented non-gesture points were simple and the other half complex, participants tended to answer the complex non-gesture points just as accurately as the simple non-gesture points. One reason that no main effect of word complexity was found for non-gesture points may be because there were fewer non-gesture points in the narrative than gesture points. As the focus of the current study was on the effect of gestures, a greater number of gesture points were created than non-gesture points. As there were fewer non-gesture points than gesture points in the narrative, it may be that there was less variability for non-gesture points than gesture points, resulting in a non-significant main effect for word complexity of non-gesture points.

A mixed pattern of means was observed for specific questions however: simple points were recalled (non-significantly) better than complex points for the typical and control conditions, whereas the opposite pattern was observed for the atypical condition. Therefore it is perhaps more likely that the non-significant main effect for word complexity was due to the characteristics of the words chosen, rather than simply being due to insufficient variability. It is possible that the non-gesture points differed in some systematic way from the words chosen as gesture points. While care was taken to ensure that the simple and complex words were counterbalanced between participants, which phrases were gesture points and which were non-gesture points was static between participants. In other words, the points chosen as gesture points remained gesture points for all participants, and in a similar manner, the non-gesture points remained non-gesture points for all participants. This aspect of the design was a result of the 10 most frequently used gestures from N. Sweller and Dargue (2013) being chosen as gesture points for the current study. An unfortunate effect of this manipulation was that no counterbalancing of gesture points and non-gesture points was possible. Future research could counterbalance gesture and non-gesture points, to prevent any unforeseen differences in the characteristics of the specific words chosen for gesture and non-gesture points. That is, for some participants a gesture would accompany a chosen word, making it a gesture point, whereas no gesture would accompany that same word for another participant, making it a non-gesture point.

Alternately, the nature of the complexity manipulation could be altered, such that instead of using simple vs. complex words, the complexity of the narrative could be manipulated through having participants complete a dual task while they watch the narrative. As working memory has been shown to play a crucial role in the comprehension of spoken language (Baddeley, 1992), increasing the load placed on working memory could indeed increase the complexity of a narrative comprehension task. Completing a simultaneous dual task, such as counting aloud, while observing a video narrative could place a larger load on working memory (Van Den Hout et al., 2011), thereby making the task harder without changing the actual narrative between participants. For example, participants could be asked to count backwards in threes from 100 to increase the load placed on working memory. In a separate between-subjects condition, other participants could perform an easier dual task, such as counting back from 100 in tens while simultaneously watching the narrative. In this way, the words contained in the narrative would remain constant between conditions, but the secondary, dual task (counting back from 100), would be manipulated for complexity. It would be expected that performance would be better in the simple than the complex condition, with no concerns regarding the specifics of the words used in the narrative.

A between-subjects manipulation with a single narrative would ensure there were no differences in the primary stimulus, which could potentially confound results. Alternately, it would be possible for such a manipulation to be completed within-subjects, with participants viewing one narrative with the simple dual task and another narrative with the complex dual task. Narratives associated with the single vs. the complex dual task could be counterbalanced between participants. Such a within-subjects design would only be possible if it were feasible to generate the large number of typical and atypical gestures that would be required if the number of narratives (and therefore gesture points) were doubled from the current experiment.

Interaction Between Word Complexity and Condition

The current study predicted that there would be an interaction between word complexity and gesture condition, such that the difference between the recall of simple and complex points in the narrative would be smaller for the gesture conditions compared with the control condition, and smaller again for the typical gesture condition compared with the atypical gesture condition. There was, however, no significant interaction between word complexity and condition for either free recall or for the specific follow-up questions. While the main effects for both free recall and specific follow-up question analyses suggested that typical gestures improved adult narrative comprehension, the gestures did not seem to be beneficial differentially across the levels of complexity. It is possible that this lack of an interaction effect was due to the nature of the complexity manipulation employed in the current study.

Cognitive Load Theory (CLT) provides guidelines for the effective presentation of information to learners in such a way that fosters and establishes learning (Castro-Alonso, Ayres, & Paas, 2014; J. Sweller, van Merrienboer, & Paas, 1998). The main construct of CLT is cognitive load: that is, the load placed on a learner’s working memory in a given learning situation (Castro-Alonso et al., 2014). CLT determines complexity by the concept of element interactivity (i.e., the number of elements that need to be simultaneously processed in the working memory of a learner when completing a task; Marcus et al., 2013; J. Sweller et al., 1998). When the cognitive load of a given task exceeds the learner's working memory capacity, the ability to learn is reduced (Castro-Alonso et al., 2014). High element interactivity puts a high load on working memory, making learning more difficult (Marcus et al., 2013).

High element interactivity is not the same as word difficulty, and this is one possible reason why a significant interaction was not obtained between word complexity and gesture condition in the current study. As a difficult word is simply one that an individual is less familiar with, it may in fact have little to do with element interactivity as defined by CLT, and as a result, little to do with working memory load. Therefore, it is possible that merely increasing the difficulty of words was not an adequate way of increasing the overall complexity of the narrative enough for the gestures to differentially take effect. Future research could manipulate the complexity of the task using a different method, such as the counting method described above, through increasing the load on working memory while watching the narrative. Such a manipulation may make the complex condition complex enough that the gestures have the potential to be more beneficial than for the simple condition.

On the other hand, it is possible that in the current study it was not that the complex points were not complex enough: rather, it may be that the *simple* points were themselves complex enough for the beneficial effects of observing gesture to be detected. Previous studies have found little benefit in observing gestures for adult learning, perhaps because the tasks used were too simple (Dargue, 2014; Kelly & Church, 1998). Although designed to be high in frequency and therefore easy to comprehend, if the simple words in the current study were still complex enough to make the narrative as a whole difficult to understand without gestures, then this may have contributed to the equivalent effect seen of the gestures on the simple and complex points.

The beneficial effects of observing typical gesture seen for adults, regardless of narrative complexity, suggest that instead of processing differences existing between how children and adults process speech and gesture, adults may in fact process speech and gesture in a similar manner to children. Specifically, it may be that adults, like children, process speech and gesture separately, and focus on the modality that provides information in the simplest form. Adults in the current study may have focussed on either the gestures or the speech, dependent on whichever modality was easiest to comprehend. If children indeed process speech and gesture separately, a similar pattern of results would be expected if an analogous study were run with children, with a main effect of gesture condition, such that typical gestures would be more beneficial than atypical gestures, regardless of narrative complexity. If typical gestures are innate and produced naturally, and are thus easy to comprehend, children will respond at test in a manner consistent with the typical gestures. However, children would be expected to ignore the atypical gestures that they have only just learnt when watching the presented narrative, and focus primarily on the spoken message. If children were to primarily focus on the spoken message, then performance in the atypical condition should be poorer than that in the typical condition. Research could further investigate whether typical and atypical gestures have a differential effect on both child and adult narrative comprehension dependent on task complexity to further clarify whether children and adults indeed process speech and gesture in a similar manner.

The Production of Spontaneous Gesture on Free Recall

Finally, it was expected that the gestures produced by participants during free recall would positively predict narrative comprehension. However, just as observing different types of gestures can have differential impacts on learning, it is possible that producing different types of gestures impacts upon narrative comprehension differentially too. That is, the production of gestures that are innate (i.e., typical gestures) may be more beneficial to narrative comprehension than the production of gestures that are learnt (i.e., atypical gestures).

Indeed, a stark difference was found between the effects seen for the production of typical gestures and atypical gestures on narrative recall. The number of typical gestures produced during free recall did significantly predict narrative comprehension beyond the total number of words spoken, whereas no significant effects were found for either atypical or other gestures. The current study is the first to empirically show that the production of innate gestures significantly positively predicts narrative comprehension, and that this effect is not replicated for either non-innate gestures, or for other, primarily beat, gestures. In essence, the results of the current study suggest that gestures are more likely to positively predict narrative comprehension if they are innate (i.e., typical) in nature, as opposed to learnt (i.e., atypical).

However, it should also be noted that the failure of the number of atypical gestures produced to predict narrative comprehension could be due to participants rarely producing atypical gestures. Although it was expected that viewing the narrative with accompanying atypical gestures would prompt participants to mimic the narrator and produce those same gestures at test, participants only did so to a very limited extent. This is perhaps unsurprising; participants may have never previously seen such gestures in the context of the phrases they accompanied, and viewing them only once in the current experiment may be insufficient exposure to elicit mimicry.

To further examine whether atypical gestures indeed positively predict narrative comprehension, the quantity of atypical gestures produced would need to be greater. Instructions regarding gesture mimicry were specifically avoided in the current study, to ensure that all gestures produced at test were spontaneous. Future research may instruct participants to imitate the gestures that they watched the narrator make during the narrative while they recall the narrative content at test. Only participants in the atypical gesture condition would be expected to produce the atypical gestures (as participants in the other conditions would not be exposed to atypical gestures), and it is therefore possible that the total number of atypical gestures produced would increase for this condition. If a greater number of atypical gestures are produced, we would then be able to better understand whether the production of atypical gestures does in fact positively predict narrative comprehension.

Alternatively, it may be that the performance of typical gestures simply lowers the cognitive load placed on working memory when recalling a previously viewed narrative to a greater extent than the performance of atypical gestures or other gestures. As we are primed to use typical gestures, such gestures are produced more naturally than the atypical gestures that participants have just learnt through watching the narrative. Thus, as participants had only just learnt the atypical gestures, they may not have been produced as readily as typical gestures. As a result, typical gestures may reduce the load on working memory to a greater extent than atypical gestures, given the greater ease with which they are produced.

Furthermore, the inability of the production of other gestures to positively predict adult narrative comprehension is noteworthy. The gestures that participants typically produced that were coded as other gestures were primarily beat gestures (i.e., rhythmic movements produced by the hands, such as a flicking or tapping motion, that are not related semantically to the content of speech; McNeill, 2000). Beat gestures primarily function as interactive gestures, in that beat gestures can be commonly used to coordinate turn taking during a conversation, request a response, or acknowledge that a spoken message was understood (Roth, 2001). Thus, the role that beat gestures have with respect to learning may not be as central as the role of iconic gestures in learning.

One major difference between beat and iconic gestures is that beat gestures bear no semantic relation to speech, whereas iconic gestures typically reinforce and relate to the content of speech. Research has shown that gesture benefits comprehension of speech best when it reinforces the information presented in speech (Goldin-Meadow, Kim, & Singer, 1999). Thus, the production of beat gestures may not be as beneficial to narrative comprehension as the typical, iconic gestures due to the beat gestures failing to reinforce speech content. It should be noted that unlike atypical gestures, which were rarely produced, beat gestures were produced quite frequently at recall. In fact, a greater number of beat gestures than typical iconic gestures were produced at recall. The inability of these other beat gestures to positively predict recall therefore cannot be attributed to a low number of such gestures being produced at test. Rather, it appears that there is an inherent difference in the ways in which typical (iconic) gestures and other (primarily beat) gestures function when recalling narrative content.

Limitations of the Current Study and Implications for Future Research

Some of the most notable limitations of the current study, as previously discussed, include the low number of non-gesture points used, and the low number of atypical gestures produced at recall. However, another possible limitation includes the inability of the current study to determine whether the production of gesture by an individual indeed improves learning through reducing the demand placed on working memory.

Although the current study found that the production of typical gestures by participants significantly predicted free recall, no measure of working memory load was used. Thus, this study could not determine whether the production of gesture indeed improves narrative comprehension through reducing the cognitive load placed on working memory. While it has been shown that the production of typical gestures predicts recall; the mechanism through which it does so cannot be determined by the current study. Future research should include a measure of cognitive load to be compared across participants at recall. Through measuring cognitive load at recall, future research would also be able to better understand whether the production of typical and atypical gestures affect cognitive load differently, and thus have different effects on learning when produced.

Furthermore, it is important to emphasise that the current study does not suggest that typical gestures are necessarily the same as biologically primary skills, or that atypical gestures are the same as biologically secondary skills. Rather, the typical gestures in the current study were designed to be naturally occurring gestures and therefore analogous to biologically primary skills. In contrast, the atypical gestures were designed to be non-naturally occurring gestures, but nevertheless gestures that still accurately reflected the associated speech content, and therefore analogous to biologically secondary skills. The current study is the first to draw the distinction between innate and learned gestures in regards to their effects on narrative comprehension in adults. A further exploration of different types of gestures is warranted, beyond the usual distinctions of iconic, deictic, metaphoric, and beat gestures.

The methodology of the current study could also be applied to children, to see whether typical and atypical gestures play a beneficial role in narrative comprehension in children. Through showing that typical gestures are more beneficial to learning than atypical gestures in adults, the current study suggests that gestures that are innate provide greater benefits to learning than those gestures that are learnt over time. Children, however, themselves produce qualitatively different gestures from adults in some situations (Austin & N. Sweller, 2015). It is unclear, therefore, whether typical and atypical gestures, two qualitatively different types of gestures, may have differing impacts on learning for children as opposed to adults. Understanding whether typical gestures benefit learning to a greater extent than atypical gestures in children may have valuable implications for education and learning. Finding the most useful gestures for educators to use has the potential to greatly enhance educational outcomes. From a theoretical perspective, research has often found observing gestures to be of greater benefit to children than to adults. Given the beneficial effect of typical gestures on adult narrative comprehension found in the current study, it is possible that even larger effects may be seen when presenting children with typical gestures.

Conclusions

The current study investigated the effect of observing and producing two forms of iconic hand gestures on adult narrative comprehension. While typical gestures were of benefit to narrative comprehension, atypical gestures did not benefit narrative comprehension on any of the measures of recall. Analogous results were seen for the production of gestures produced by participants at recall: the production of typical gestures positively predicted performance at test, while the production of atypical gestures did not. These results suggest that not all gestures are equal: those we produce naturally are of the greatest benefit, while other, less naturally occurring gestures may be no better than viewing no gestures at all. While research has previously split gestures into categories such as iconic, deictic, metaphoric, and beat gestures and noted the benefits each has for learning, this study is the first to distinguish between gestures that are innate and those that are learnt. Just as the chest beat performed by gorillas is vital for communication, similar, naturally occurring gestures may be used by humans not only to aid in communication, but also to help us learn.

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Appendix A: Macquarie University PSYC104/PSYC246 Participant Advertisement

Narrative Comprehension (English first language speakers only)

Credit per participant: 30 minutes

You are invited to participate in a study of the ability of adults to comprehend a visual narrative. The aim of this study is to examine several of the psychological factors underlying the narrative comprehension of adults. This research may have important implications for education and learning. If you decide to participate, you will be asked to attend to a short visual narrative, participate in a brief interview, and complete a test of receptive language ability using the reputable Peabody Picture Vocabulary Test (Dunn, L.M., & Dunn, D.M., 2007).

All participants will be audio and video-recorded while relaying information in order to assess performance on the task. The study will take approximately 30 minutes to complete.
Participants are required to be fluent in English as they will be verbalising information.

Eligibility: PSYC104, PSYC105, and PSYC246 students.

Appendix B: Analyses Excluding Participants with Comprehension Lower than 18 Years of Age as Measured by the PPVT-4

Table 1

Simple and Complex Mean (and Standard Deviation) Free Recall Scores on Gesture Points by Condition Excluding Participants with Comprehension Lower than 18 Years of Age

	Condition		
Word Complexity	Typical	Atypical	Control
Simple	1.87 (1.28)	1.55 (1.09)	1.17 (1.13)
Complex	1.40 (.97)	1.26 (1.13)	1.00 (.89)

Note. Standard Deviations appear in parentheses.

Table 2

Free Recall Test

	F	Partial η^2	*p*
Condition	4.097	.05	.046
Complexity*Condition	.318	.01	.728

Table 3

Pairwise Comparison of Condition

	F	Partial η^2	*p*
Typical vs. Control	5.718	.12	.019
Typical vs. Atypical	1.144	.05	.289
Atypical vs. Control	1.953	.05	.166

Table 4

Simple and Complex Mean (and Standard Deviation) Free Recall Scores on Non-Gesture Points by Condition Excluding Participants with Comprehension Lower than 18 Years of Age

	Condition		
Word Complexity	Typical	Atypical	Control
Simple	.53 (.63)	.65 (.71)	.46 (.59)
Complex	.50 (.63)	.55 (.68)	.25 (.44)

Note. Standard Deviations appear in parentheses.

Table 5

Free Recall Test

	F	Partial η^2	*p*
Condition	1.574	.02	.213
Complexity*Condition	.304	.01	.739

Table 6

Mean (and Standard Deviation) Non-Manipulated Point Free Recall Scores by Condition

	Condition		
	Typical	Atypical	Control
Non-Manipulated	7.20 (2.83)	6.48 (3.40)	6.00 (3.56)

Note. Standard Deviations appear in parentheses.

Table 7

Free Recall Test

	F	Partial η^2	*p*
Condition	.944	.02	.393

Table 8

Simple and Complex Mean (and Standard Deviation) Gesture Point Follow-Up Question Scores by Condition Excluding Participants with Comprehension Lower than 18 Years of Age

	Condition		
Word Complexity	Typical	Atypical	Control
Simple	7.43 (1.41)	6.55 (1.61)	6.46 (1.80)
Complex	7.13 (2.10)	5.81 (2.17)	5.71 (1.90)

Note. Standard Deviations appear in parentheses.

Table 9

Follow-Up Questions Test

	F	Partial η^2	*p*
Condition	3.904	.05	.052*
Complexity*Condition	.251	.01	.778

* The main effect for gesture condition is the only analysis which became non-significant when excluding the 45 participants with comprehension lower than 18 years of age.

Table 10

Simple and Complex Mean (and Standard Deviation) Non-Gesture Point Follow-Up Question Scores by Condition Excluding Participants with Comprehension Lower than 18 Years of Age

	Condition		
Word Complexity	Typical	Atypical	Control
Simple	3.60 (1.07)	3.03 (1.22)	3.50 (1.22)
Complex	3.10 (.995)	3.32 (1.40)	3.12 (1.08)

Note. Standard Deviations appear in parentheses.

Table 11

Follow-Up Questions Test

	F	Partial η^2	*p*
Condition	1.524	.02	.221
Complexity*Condition	2.592	.06	.081

Table 12

Mean and Standard Deviation for Free Recall, Typical Gestures Produced, Atypical Gestures Produced, Other Gestures Produced, and Number of Words Spoken Excluding Participants with Comprehension Lower than 18 Years of Age

Variable	*M*	*SD*
Free Recall	9.72	4.66
Typical Gestures Produced	1.23	1.71
Atypical Gestures Produced	.08	.320
Other Gestures Produced	5.97	5.92
Words Spoken	114.64	64.73

Table 13

Regression Output for Typical Gestures Produced Excluding Participants with Comprehension Lower than 18 Years of Age

	β	*p*
Typical Gestures	.469	.015
Words Spoken	.053	.000

$R^2 = .69$, $F(2, 82) = 90.60$

Table 14

Regression Output for Atypical Gestures Produced Excluding Participants with Comprehension Lower than 18 Years of Age

	β	*p*
Atypical Gestures	.713	.391
Words Spoken	.059	.000

$R^2 = .67$, $F(2, 82) = 82.52$

Table 15

Regression Output for Other Gestures Produced Excluding Participants with Comprehension Lower than 18 Years of Age

	β	*p*
Other Gestures	.041	.487
Words Spoken	.057	.000

$R^2 = .67$, $F(2, 82) = 82.14$

Appendix C: Narrative Gesture and Non-Gesture Points

Gesture points are in **bold**; Non-Gesture points are in *italics*.

<u>Donald's Garden</u>

Donald Duck had a garden full of watermelons and one of them had won **first prize** at a local fair. While watering his garden, Donald Duck noticed that he had run out of water, so he *skipped* over to a water station to refill his bucket.

When Donald Duck first **siphoned** water out using the lever, the water did not fill up the bucket because the water only *percolated out*. When Donald Duck tried to use the lever again, the water came out too far. This *frustrated* Donald because he could not seem to fill up his bucket with water.

After using the lever again, the water finally went into the bucket. However, the water kept *emanating out* of the water station and pushed the bucket over to a ledge, where it began to **tilt back and forth**. Donald rushed over to the ledge to try and stop the bucket from falling, but it was too late. The bucket had fallen off the ledge, spilling all of the water onto the ground.

Donald Duck **hoisted up the bucket** and took it back to the water station. This time, Donald Duck moved the lever up and down so fast that the water station began to **expand** but only a drop of water came out. Donald duck looked into the tap to see why the water was not coming out, and all of a sudden, water began spurting out **straight into Donald duck's oculus**.

Donald Duck then moved the lever up and down as fast as it could go. A stream of water spurted out, but it **kept moving back and forth out of Donald Duck's reach** as he chased it with his bucket. He continued to chase the water all the way back to the water station, but he ran so fast that his *nose got stuck in the nozzle* and water **burst out of his nares**. Donald Duck slammed the bucket down in front of the water station and moved the lever up and down once more. The pressure in the water station built up so much that water came blasting out which caused Donald Duck to get **pushed up**.

When Donald Duck landed back on the ground he noticed that his bucket had been filled up with water. As he went to get it, the **bucket disunited**, leaving the water sitting there in the shape of a bucket. Donald Duck watched as the water burst. He looked down at the puddle quacking angrily, and watched as the water slowly *evanesced into a hole in the ground*.

Appendix D: Narrative Total Phrases

Donald's Garden

Donald Duck had a **garden** full of **watermelons** and one of them had **won first prize** at a **local fair**. While **watering his garden**, Donald Duck noticed that **he had run out of water**, so he **skipped** over to a **water station** to **refill his bucket**.

When Donald Duck first **siphoned** water out **using the lever**, the water **did not fill up the bucket** because the water only **percolated out**. When Donald Duck tried to **use the lever again**, the **water came out too far**. This **frustrated** Donald because he **could not seem to fill up** his bucket with water.

After **using the lever again,** the **water finally went into the bucket**. However, the water kept **emanating out of the water station** and **pushed the bucket** over to a **ledge**, where it began to **tilt back and forth**. Donald **rushed over to the ledge** to try and **stop the bucket from falling**, but **it was too late.** The **bucket had fallen off the ledge**, spilling all of the **water onto the ground.**

Donald Duck **hoisted up** the bucket and **took it back to the water station**. This time, Do**nald Duck moved the lever up and down so fast** that the **water station began to expand** but only **a drop of water came out.** Donald duck **looked into the tap** to **see why the water was not coming out,** and all of a sudden, **water began spurting out** straight into Donald duck's **oculus.**

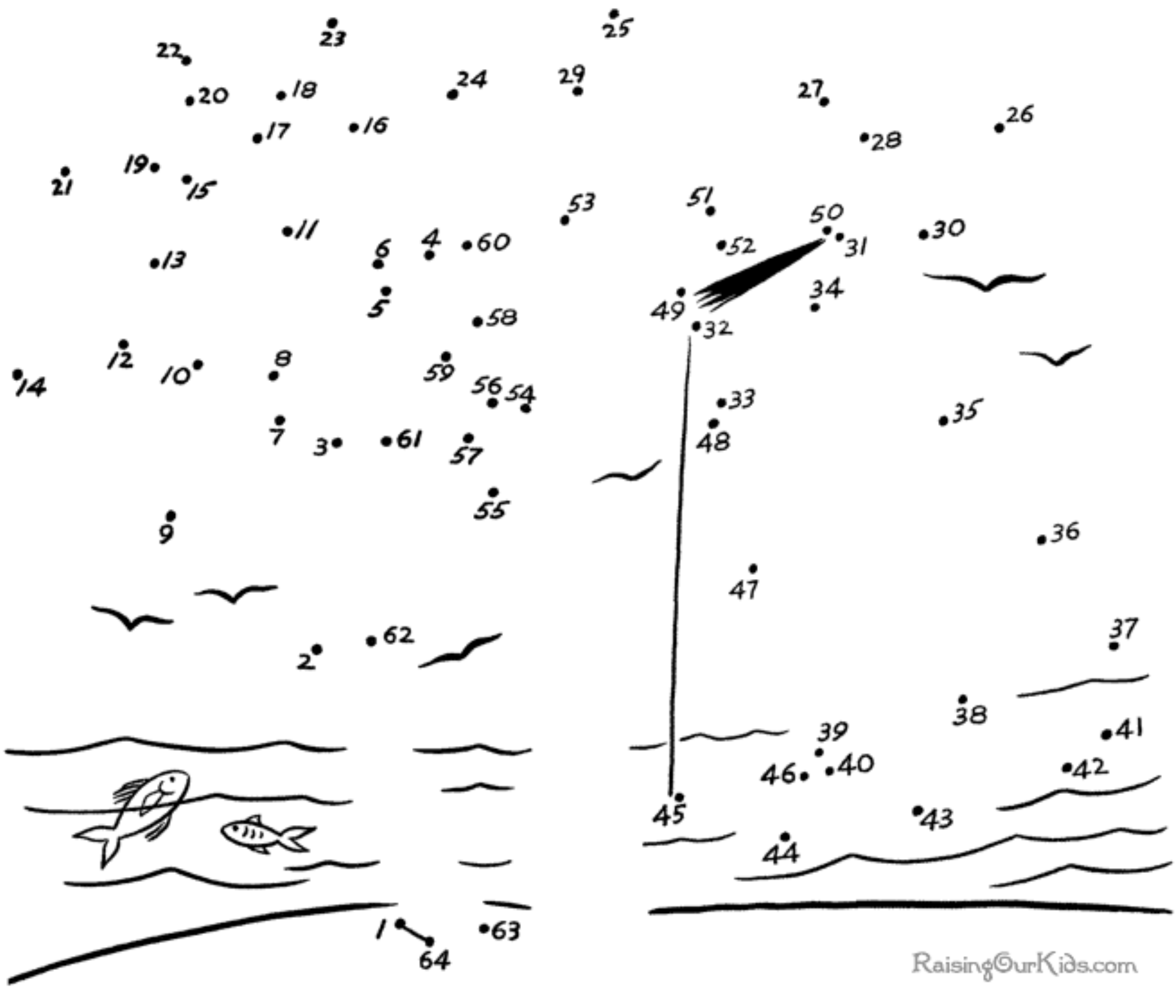
Donald Duck then moved the lever up and down as fast as it could go. A stream of **water spurted out**, but it **kept moving back and forth out of Donald Duck's reach** as **he chased it with his bucket**. He continued **to chase the water** all the way **back to the water station**, but he **ran so fast** that his **nose got stuck** in the nozzle and **water burst out of his nares**. Donald Duck **slammed the bucket down** in front of the **water station** and moved the **lever up and down once more**. The pressure in **the water station built up** so much that **water came blasting out** which caused Donald Duck **to get pushed up**.

When Donald Duck landed back on the ground he noticed that his bucket had **been filled up with water**. As he **went to get it**, the **bucket disunited**, leaving the **water sitting there in the shape of a bucket**. Donald Duck **watched as the water burst.** He **looked down at the puddle** quacking **angrily**, and **watched** as the water slowly **evanesced into a hole in the ground.**

Appendix E: Counterbalanced Simple and Complex Words

	Easy/complex	**Complex/easy**
Gesture Points	First	Highest laurels
	Siphoned	Pumped
	Tilt back and forth	Teeter
	Hoisted up	Picked up
	Expand	Distend
	Oculus	Eye
	Moving back and forth	Vacillating
	Nares	Nostrils
	Pushed up	Levitated
	Disunited	Broke
Non-Gesture points	Skipped	Capered
	Percolated	Dribbled
	Frustrated	Embittered
	Emanating	Spurting
	Nose	Snuffer
	Evanesced	Disappeared

Appendix F: Filler Task



Appendix G: Interview Script

Now I am going to ask you some questions about the video that you saw on the computer earlier. If you don't know the answers you can just guess ok?

Free Recall Question: First, tell me everything you remember about the story you saw earlier.

Now I am going to ask you a few more questions about the video. The questions I am going to ask won't necessarily be in the same order as what you saw in the video.

Specific Follow-up Questions for Non-Gesture Points:

1. What caused the bucket to move towards the ledge?
    a. Did the water spurt out and push the bucket towards the ledge or did Donald Duck place the bucket on the ledge?
2. What happened the first time Donald Duck tried to refill the bucket?
    a. Did the water dribble out or go too far the first time Donald Duck tried to refill the bucket?
3. How did Donald Duck feel when the water wasn't going into the bucket?
    a. Did Donald Duck feel sad or frustrated?
4. What happened to Donald Duck's beak?
    a. Did Donald Duck's beak get stuck in the water station or did he get squirt by the water in his beak?
5. Where did the water go in the end?
    a. Did the water stay in the bucket or did it disappear into a hole in the ground?
6. How did Donald Duck initially make his way over to the water station?
    a. Did Donald Duck skip or run to the water station initially?

Specific Follow-up Questions for Gesture Points:

7. What place did Donald Duck win at the fair?
    a. Did Donald Duck win first prize or runner up?
8. What was Donald Duck doing to get the water into the bucket?
    a. Was Donald Duck pumping or turning on a tap to get the water into the bucket?
9. What happened to the bucket when it was on the ledge?
    a. Did the bucket wobble or fall straight off the side?
10. What did Donald duck do after the bucket fell over?
    a. Did Donald Duck pick up the bucket or leave it on the ground?
11. What happened to the water station when Donald Duck was moving the lever up and down really fast?
    a. Did the water station start to expand or explode when Donald Duck was moving the lever up and down really fast?
12. Where did the water squirt Donald Duck?
    a. Did the water squirt Donald Duck in the eye or in his mouth?
13. What did the water keep doing when Donald Duck kept trying to fill up his bucket?
    a. Did the water go into the bucket each time or did the water keep moving back and forth out of Donald Ducks reach?
14. Where did the water come out of Donald Duck?
    a. Did the water burst out of Donald Duck's nostrils or ears?
15. Where did the water push Donald Duck?
    a. Did the water push Donald Duck up into the sky or down to the ground?

16. What happened to the bucket in the end?
    a. Did the bucket break or did Donald Duck use it to go and water his garden?

Appendix H: Macquarie University PSYC104/PSYC246 Participant Consent Form

Dr Naomi Sweller
Department of Psychology
MACQUARIE UNIVERSITY
NSW 2109 AUSTRALIA
Phone +61(2) 9850 8084
Fax +61(2) 9850 8062
Email naomi.sweller@mq.edu.au

Information Statement and Consent Form

Narrative Comprehension

You are invited to participate in a study of people's ability to comprehend a visual narrative. The purpose of the study is to examine several of the psychological factors underlying the narrative comprehension of adults. This research may have important implications for education and learning. Participants are required to be fluent in English as they will be verbalising information.

The study is being conducted by Dr Naomi Sweller (Phone: (02) 9850 8084, Email: naomi.sweller@mq.edu.au) and Miss Nicole Dargue (Phone: 0423 277 100, Email: nicole.dargue@students.mq.edu.au) of the Department of Psychology. It will form the basis for the award of Masters of Research under the supervision of Dr Naomi Sweller.

If you decide to participate, you will be asked to view a short visually recorded narrative and a brief interview. This will be followed by the completion of a short test of comprehension using the Peabody Picture Vocabulary Test (PPVT; Dunn, L.M., & Dunn, D.M., 2007). The study will take approximately 30 minutes to complete. All participants will be audio and video-recorded while completing the interview in order to assess performance on the task. Performance on the PPVT will not be video or audio recorded. Although not expected, should you experience any distress during the study please inform the experimenter immediately. Further, should you experience any issues on conclusion of the study please feel free to contact Dr Naomi Sweller. You will be awarded with 30 minutes course credit for your participation.

Any information or personal details gathered in the course of the study are confidential. No individual will be identified in any publication of the results. The data will be accessible only to Nicole Dargue and Dr Naomi Sweller and will be stored in a locked filing cabinet in the chief investigator's Macquarie University Office. All electronic data, including video-recorded data, will be kept on password-protected computers. A summary of the results of the study will be made available to students on request through contacting Nicole Dargue or Dr Naomi Sweller in October 2015.

Participation in this study is entirely voluntary: you are not obliged to participate and if you decide to participate, you are free to withdraw at any time without having to give a reason and without forfeiting your course credits.
.

I, __________________ have read and understand the information above and any questions I have asked have been answered to my satisfaction. I agree to participate in this research, knowing that I can withdraw from further participation in the research at any time without consequence. I have been given a copy of this form to keep.

Participant's Name:____
(Block letters)

Participant's Signature: _________________________ Date:___________________

Investigator's Name:____
(Block letters)

Investigator's Signature: _____________________ __ Date:___________________

The ethical aspects of this study have been approved by the Macquarie University Human Research Ethics Committee. If you have any complaints or reservations about any ethical aspect of your participation in this research, you may contact the Committee through the Director, Research Ethics (telephone (02) 9850 7854; email ethics@mq.edu.au). Any complaint you make will be treated in confidence and investigated, and you will be informed of the outcome.

(INVESTIGATOR'S [OR PARTICIPANT'S] COPY)

Appendix I: PSYC246 Study Summary

The Effect of Typical and Atypical Gestures on Narrative Comprehension

Universally, people have the tendency to produce hand gestures when they speak (Goldin-Meadow, 2000). Through providing visual cues that may aid comprehension, it can be assumed that the hand gestures people make when conversing with one another serve a communicative function (Eysenck & Keane, 2010, p. 425), and may provide important insights into cognitive development, comprehension, and language (Kelly, Manning & Rodak, 2008). If people are to learn from observing another's gestures, the types of gestures observed are likely to be crucial. Past research has suggested that the complexity of a task may influence how beneficial observing a corresponding gesture is to task performance, such that gestures are more beneficial when a task is complex (McNeil, Alibali, & Evans, 2000). As it is unclear whether this applies to narrative comprehension the current study aims to determine whether gestures are of more benefit to narrative comprehension when accompanying complex information. The present study also aims to explore whether typical gestures aid narrative comprehension to a greater extent than atypical gestures. As typical skills are learnt more easily than atypical skills (Sweller, 2009), it is thought that perceiving typical gestures will benefit narrative comprehension to a greater extent than atypical gestures.

Text-book link

Eysenck, M.W., & Keane, M.T. (2010). Language Production. In Eysenck, M.W., & Keane, M.T. (Ed.), *Cognitive psychology: A student's handbook* (6th ed., pp. 417-458). New York, NY: Psychology Press.

References

Goldin-Meadow, S. (2000). Beyond words: The importance of gesture to researchers and learners. *Child Development*, *71*, 231-239.

Kelly, S.D., & Church, R.B. (1998). A comparison between children's and adult's ability to detect conceptual information conveyed through representational gestures. *Child development*, *69*, 85-93.

Kelly, S.D, Manning, S.M., & Rodak, S. (2008). Gesture gives a hand to language and learning: Perspectives from cognitive neuroscience, developmental psychology and education. *Language and Linguistics Compass*, *2*, 569-588.

McNeil, M.N., Alibali, M.W., & Evans, J.L. (2000). The role of gesture in children's comprehension of spoken language: Now they need it, now they don't. *Journal of nonverbal behavior*, *24*, 131-150.

Sweller, J. (2009). Cognitive bases of human creativity. Educational Psychology Review, 21, 11-19. doi: 10.1007/s10648-008-9091-6

Appendix J: Final Ethics Approval Letter

OFFICE OF THE DEPUTY VICE-CHANCELLOR
(RESEARCH)
Research Office
C5C East Research HUB, Level 3

MACQUARIE
University
SYDNEY·AUSTRALIA

4 December 2015

Dr Naomi Sweller
Department of Psychology
Faculty of Human Sciences
Macquarie University NSW 2109

Reference: 5201500047

Dear Dr Sweller,

FINAL APPROVAL

Title of project: The Effect of Typical and Atypical Gestures on Adult Narrative Comprehension

Thank you for your recent correspondence. Your response has addressed the issues raised by the Faculty of Human Sciences Human Research Ethics Sub-Committee. Approval of the above application is granted, **effective 5th March 2015** and you may now commence your research.

This research meets the requirements of the National Statement on Ethical Conduct in Human Research (2007). The National Statement is available at the following web site:

http://www.nhmrc.gov.au/book/national-statement-ethical-conduct-human-research

The following personnel are authorised to conduct this research:

Chief Investigator: Dr Naomi Sweller
Co-Investigator: Miss Nicole Dargue

Please note the following standard requirements of approval:

1. The approval of this project is conditional upon your continuing compliance with the National Statement on Ethical Conduct in Human Research (2007).

2. Approval will be for a period of five (5) years subject to the provision of annual reports.

Progress Report 1 Due: 5th March 2016
Progress Report 2 Due: 5th March 2017
Progress Report 3 Due: 5th March 2018
Progress Report 4 Due: 5th March 2019
Final Report Due: 5th March 2020

NB. If you complete the work earlier than you had planned you must submit a Final Report as soon as the work is completed. If the project has been discontinued or not commenced for any reason, you are also required to submit a Final Report for the project.

Progress reports and Final Reports are available at the following website:

http://www.research.mq.edu.au/current_research_staff/human_research_ethics/application_resources

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OFFICE OF THE DEPUTY VICE-CHANCELLOR (RESEARCH)
Research Office
C5C East Research HUB, Level 3

MACQUARIE University
SYDNEY·AUSTRALIA

3. If the project has run for more than five (5) years you cannot renew approval for the project. You will need to complete and submit a Final Report and submit a new application for the project. (The five year limit on renewal of approvals allows the Committee to fully re-review research in an environment where legislation, guidelines and requirements are continually changing, for example, new child protection and privacy laws).

4. All amendments to the project must be reviewed and approved by the Committee before implementation. Please complete and submit a Request for Amendment Form available at the following website:

http://www.research.mq.edu.au/current_research_staff/human_research_ethics/application_resources

5. Please notify the Committee immediately in the event of any adverse effects on participants or of any unforeseen events that affect the continued ethical acceptability of the project.

6. At all times you are responsible for the ethical conduct of your research in accordance with the guidelines established by the University. This information is available at the following websites:

http://www.mq.edu.au/policy/
http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_research_ethics/policy

If you will be applying for or have applied for internal or external funding for the above project it is your responsibility to provide Macquarie University's Research Grants Officer with a copy of this letter as soon as possible. The Research Grants Officer will not inform external funding agencies that you have final approval for your project and funds will not be released until the Research Grants Officer has received a copy of this final approval letter.

Yours sincerely,

Dr Anthony Miller
Chair
Faculty of Human Sciences Ethics Review Sub-Committee
Human Research Ethics Committee