Effects of Iconic Gestures on Word Pair Learning in Autistic and Non-autistic Adults

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EFFECTS OF ICONIC GESTURES ON WORD PAIR LEARNING IN AUTISTIC AND NON-AUTISTIC ADULTS

A Thesis

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Master of Arts in

The Department of Communication Sciences and Disorders

by

Caprielle Grace Priola
B.A., Louisiana State University, 2022
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Abbreviations

JOC  Judgement of Confidence
JOL  Judgement of Learning
RQ   Research Questions
W1   Word 1
W2   Word 2
Abstract

Previous studies have demonstrated that simultaneous speech and iconic gestures enhance learning and memory for listeners. Additionally, metacognitive awareness, which can be measured through judgements of learning (JOLs), has also been shown to impact learning and memory. However, it has not been established that these benefits apply to all learners. Existing studies on gesture processing and metacognitive abilities in autistic adults yield mixed findings. The present study aims to investigate the impact of co-speech iconic gestures on word pair recall and perceived learning (JOLs) in autistic and non-autistic adults.

Forty non-autistic adults and 40 autistic adults participated in an online experiment. Participants listened to a spoken sentence including an unrelated predicate-noun word pair at the end while watching a video of a model producing either an iconic gesture (that matched the spoken predicate) or no gesture. After each sentence, participants rated the likelihood of remembering the word pair at a later time by providing a JOL. Word pair memory was tested using a free recall test.

Repeated measures mixed analyses of variance (ANOVA) revealed a main effect of condition on word 1 (W1) and recall of whole word pairs, with no main effect of group or group by condition interaction. There was no main effect of condition, group, or group by condition for word 2 (W2). Word 2 recall was marginally increased in the gesture condition; again, there was no significant effect of group or group by condition interaction. Complementing the recall findings, the JOL analysis revealed a main effect of condition with no group or group by condition effect. Autistic and non-autistic learners perceived the learning and memory of word pairs to be enhanced when the W1 was accompanied by a semantically matching iconic gesture.
Thus, the current findings indicate that word memory for autistic and non-autistic learners benefits to a similar extent from co-speech iconic gestures, and that both groups perceive this benefit similarly. These findings align with previously published co-speech gesture memory research and extend it to autistic learners. Additionally, these findings support emerging findings that autistic learners process gestures similarly to non-autistic learners.
Chapter 1. Introduction

Cross-modal learning involves input or stimuli from more than one modality. The vast majority of learning research focuses on within-modality learning, particularly within the associative learning and memory literature (e.g., Chen et al., 2019; McNeill, 1966; Whiffen & Karpicke, 2017; Zhang et al., 2019). However, humans are multi-modal learners and communicators. In order to obtain a more comprehensive understanding of the way individuals communicate and learn, we must consider multi-model learning rather than learning within a single modality. This aim is particularly important to investigate in groups that may sometimes struggle to process multimodal information, like autistic individuals. Therefore, the current study aims to examine multimodal learning and memory in autistic and non-autistic adults.

Interpersonal communication often incorporates speech, gestures, facial expressions, other forms of body language, and sometimes written text. A person may communicate their emotions using facial expressions, body language, and speech. Someone may use printed text coupled with a verbal explanation to convey a new idea. A teacher may instruct a math lesson using verbal explanation, gestures, manipulation of objects, symbols, and pictures. Numerous studies indicate that it is beneficial to use gestures alongside speech in the classroom (Alibali et al., 2014; Congdon et al., 2017; M. A. Novack et al., 2014; M. Novack & Goldin-Meadow, 2015). Congdon et al. (2017) found that the use of simultaneous speech and gesture instruction during a math lesson resulted in improved retention and generalization of information in children compared to teaching with the same speech and gesture presented sequentially. In another study, Novack et al. (2014) investigated whether gestures promoted learning due to the gesture’s representation of abstract ideas or the physical movement of the gesture. Novack et al. (2014) found that instructors acting out on objects resulted in a shallower understanding of math
concepts compared to when the math concepts were presented with gestures. Though these initial studies have demonstrated the benefits to learning when incorporating gestures, it has not been established that co-speech gestures enhance learning in all learners. Autistic individuals may encounter learning difficulties at times (Van Hees et al., 2015). Relatedly, there is limited information about gesture processing and gesture production in autistic individuals. Though mixed findings have been reported (Dimitrova & Özçalışkan, 2022; Sowden et al., 2008), some studies reveal differences in the gesture production of autistic individuals (de Marchena et al., 2019). The current study specifically aims to examine the use of gestures to enhance the learning of associations between pairs of words in autistic and non-autistic adults. Additionally, the current study examined autistic and non-autistic individual’s metacognitive judgements of learning during a learning experience.

**Gestures**

Gestures could be defined as "any communicative hand movement," excluding routine-based games and the manipulation of objects (Özçalışkan & Goldin-Meadow, 2009, p. 193). While there is variability across cultures, age, and context, gestures are a crucial aspect of human communication (Kwon et al., 2018). For instance, researchers have found that early gestures such as pointing are closely linked to the development of a child’s receptive vocabulary at later points in development (McGillion et al., 2016).

Gestures have been defined and organized into various categories using a variety of labels. Efron (1941) classified gestures using the terms physiographics, kinetographics, deictics, and batons. Freedman and Hoffman (1967) used the categories of literal-reproductive, concretization, major and minor qualifying, punctuating, and speech failures. Ekman and Friesen (1967) used a classification scheme that divided gestures into kinetographs, pictographs,
ideographs, underliners, spatially, deictics, batons, and rhythmics. This study will use the classification scheme described by McNeill in his book *Hand and mind: What gestures reveal about thought* (1992). McNeill divided gestures into four major categories including: iconic, metaphor, deictic, and beat. The purpose of the gesture could also be associated with general functions, including but not limited to discourse, narrative, and metanarrative functions. These were also able to be used to describe child development and aphasic breakdown patterns.

Iconic gestures are used to depict spatial relationships, characteristics of objects, and actions. An iconic gesture often conveys aspects of the scene presented in the speech (McNeill, 1992; McNeill & Levy, 1982). Two examples of iconic gestures are moving your hands like scissors that are cutting and an arm flapping gesture that resembles a flying bird. Metaphoric gestures share similarities with iconic gestures as they also convey visual imagery; however, instead of representing concrete objects or events, they depict abstract concepts (McNeill, 1992). Metaphoric gestures are inherently more complex as they must illustrate the relationship between two distinct things rather than creating a direct resemblance as an iconic gesture (McNeill, 1992). For instance, drawing a line in the air with one’s finger can represent a boundary or distinction between two ideas. Deictic gestures include pointing, giving, and showing gestures (McGillion et al., 2016). Deictic pointing typically involves the index finger, but any object or body part can be used, such as the nose, head, chin, or any manipulated object. In the context of narratives, deictic gestures do not solely necessitate pointing to a present physical object. Deictic gestures can also be used to identify and segment areas within the gesture space, calling attention to something that has been or will be defined in that location within the gesture space. Beat gestures do not represent a specific meaning. These gestures are used to emphasize, punctuate, or add rhythm to co-occurring speech. They are identifiable based on their typical movement characteristics as
they are usually made up of two small, low-energy swift flicks of the fingers and/or hand (McNeill, 1992).

**How gestures influence learning and memory**

Cairney, West, and colleagues (2024) evaluated the comparative benefit of meaningful versus nonsense co-speech gestures on learning and memory for novel word associations. The researchers examined whether gestures benefited learning and memory, potentially because gestures may enhance attention, and whether the meaningfulness of the gestures impacted these benefits. Co-speech gestures play a significant role in facilitating communication, aiding word predictability, and enhancing memory recall in various contexts (Beattie & Shovelton, 2001; Thompson et al., 1998). One possibility is that memory benefits are the result of gestures drawing increased attention to the speech input (Beattie & Shovelton, 2001; Thompson et al., 1998), essentially serving an “attentional highlighting” function. Beat gestures are one example of gestures being used to emphasize or draw attention to one’s speech. If the benefit of co-speech gestures only relied on attentional highlighting, there would likely be an equal benefit from utilizing meaningful and nonsense co-speech gestures.

Dual coding theory (Paivio, 1969) proposes that information is stored in our memory through both visual and verbal representations of information. This provides additional mental representation, which in turn enhances memory retention (Paivio, 1969). When a concept is presented in visual or imageable form, it is more likely to be remembered. It is proposed that this imagery helps in the process of forming connections to other stimuli. To illustrate this, Paivio (1965) examined associative memory of written, unrelated word pairs. The word pairs either consisted of two concrete nouns, two abstract nouns, or a combination of concrete and abstract nouns. The participants read the word pairs from 4 by 6-inch index cards. The findings revealed
that word pair memory was better when the first word was more concrete, irrespective of whether the second word was concrete or abstract (Paivio, 1965). Stemming from the dual coding theory, the conceptual peg hypothesis suggests that concrete or imageable words or concepts serve as mental “pegs” onto which other information can be hung for easier recall (Paivio, 1965).

Cairney, West et al. (2024) examined the applicability of the conceptual peg hypothesis to gesture in a series of co-speech gesture experiments. In the first experiment, the researchers presented participants with video stimuli of word pairs that were presented auditorily and an actor who either produced an iconic gesture, a beat gesture, or no gesture at the same time that the first word was played. The iconic gesture and spoken word pairing matched in meaning (e.g., spoken word “cutting” and a pair of scissors cutting iconic gesture). The participants were instructed to watch the videos and memorize the word pairs to the best of their ability. The instructions also included a suggestion to picture the word pair in their mind. For instance, if the word pair was “typing flower,” the individual may try to imagine a flower that had arms and hands that were typing on a typewriter. After listening to each word pair, participants were prompted to rate the imageability of the word pair. Then, following a distractor task at the end of each experimental block, the participants were given a pen and paper and were instructed to write as many of the word pairs as they could remember. Cairney, West et al. (2024) found that when presented with iconic gestures participants remembered the first word of the pair better than when presented with beat gestures or when gestures were absent. This was also true for the second word of these pairs. Cairney, West et al. (2024) also found that word pairs that were paired with iconic and beat gestures were rated by the participants as having higher imageability relative to word pairs that were in the no gesture condition. The authors suggested these findings
could be due to iconic gestures improving mental imagery and adding concreteness to these word pairs and therefore facilitating memory of both the first word and the second word. However, this could also be due to the iconic gestures being more attentionally engaging. Therefore, a follow-up study was conducted.

In their second experiment, Cairney, West, and colleagues (2024) replaced beat gestures with nonsense gestures, and continuous EEG was recorded. These nonsense gestures were constructed to have a similar range of movement to the iconic gestures in order to control for the potential attentional disparity between iconic and beat gestures. These nonsense gestures conveyed little to no semantic meaning, confirmed by a previous norming study (Cairney et al., 2023). The authors found that when nonsense and iconic gestures were presented with the word pairs, participants rated the imageability of the word pairs higher than those presented without gestures. Particularly, iconic gestures were associated with higher imageability ratings than imageability ratings for words that were not paired with a gesture. Furthermore, recall of the first word in each pair benefited most when it was presented with an iconic gesture. However, iconic gestures only benefited recall of the first word; recall of the whole word pairs did not significantly differ across the iconic, nonsense, and no gesture conditions.

When examining the ERP data from the second experiment, Cairney, West et al. (2024) primarily focused on N700, a late frontal slow wave ERP component that is related to mental imagery. The ERP results indicated that the second word of the pairs that were presented with iconic gestures had higher imageability, evidenced by a more robust N700, relative to words that were paired with nonsense gestures. Furthermore, while imageability increased and memory of the first word improved with the presentation of iconic gestures, unlike in experiment one, the associative memory of the word pairs did not improve. The authors suggested that the change
from a more simplistic beat gesture to a more complex nonsense gesture may have been more cognitively taxing, resulting in less associative memory benefit for trials across all conditions. Cairney, West et al. (2024) also suggested that the recorded ERPs elicited by the second word indicated that ambiguous gestures may have caused an attentional shift towards all gesture types and the first words while diverting focus away from the second words. Thus, the ambiguous gesture pairing with the first word could have detracted from processing the second presented word.

In experiment three, Cairney and colleagues used the same set of word pairs with an iconic gesture condition and a no gesture condition. The researchers removed the nonsense gestures in order to minimize the attentional shift that was found in experiment two. They found a similar pattern to the experiment one findings, with associative memory (i.e., word pair memory) benefits in the iconic gesture condition. Additionally, a larger N700 was elicited by the second word if the first word in the word pair was accompanied by an iconic gesture than when the first word was not accompanied by a gesture. This increase in N700 amplitudes indicated that iconic gestures heightened associative imagery, as initially suspected in experiment one. Across the three experiments, Cairney, West et al. (2024) found that when a listener is anticipating gestures to be both meaningful and unambiguous, iconic gestures enhance associative memory.

**Gesture processing and production in autism**

Currently, there is limited research on gesture production and comprehension in autistic individuals. Autistic individuals have challenges with social communication and interaction and display restricted and repetitive patterns of behavior, interests, or activities (American Psychological Association, 2013). In the autism community, a variety of opinions exist regarding person-first and identity-first language; however, the majority of the autistic community prefers
identity-first language (Taboas et al., 2023). Thus, this paper will use identity-first language (i.e., an autistic individual rather than an individual with autism).

As previously discussed, gestures are a predictor of language in typically developing children (McGillion et al., 2016). While there are quantitative and qualitative differences between gesture use in non-autistic and autistic infants, gesture use is also associated with language development in both groups. Young autistic children, on average, produce fewer gestures and display differences in the type of gestures (Ramos-Cabo et al., 2019). In a study that examined different types of gesture production, autistic children were the only group of children to use instrumental gestures when compared to children with Down syndrome and non-autistic peers (Mastrogiuseppe et al., 2014). Instrumental gestures are those in which the infant is taking the hand or arm of a caregiver to direct them to take a certain action. Autistic children also produce fewer deictic declarative gestures. Deictic declarative gestures are used to direct a communication partner’s attention to an object, location, or event of interest and are more social than imperative gestures, which function as requests. Deictic declarative gestures are predictive of later language development in both autistic and non-autistic children (Özçalışkan et al., 2016). Autistic children also produce a higher frequency of ritualistic imperative gestures, which are simpler communicative acts, relative to non-autistic children (Özçalışkan et al., 2016; Ramos-Cabo et al., 2019).

Adolescents are believed to reach adult levels of gestural complexity (McNeill, 1992). Silverman et al. (2010) examined speech and gesture integration in autistic adolescents. The autistic and non-autistic adolescents were matched on age, socioeconomic status, gender, verbal IQ, race/ethnicity, as well as expressive and receptive vocabulary skills. The adolescents were presented with a comprehension task that included a speech and iconic gesture condition as well
as a speech-only condition. Participants were shown video clips where a woman described complex shapes. Some videos included speech-only descriptions, and others included both speech and semantically aligning gestures during the descriptions. The participants were instructed to click the shape in a field of four options that best matched the woman’s description. Furthermore, the adolescents completed a separate task that measured unimodal iconic gesture processing.

Silverman et al. (2010) found that the autistic and non-autistic groups exhibited no significant differences in decoding the iconic gestures when they were presented in isolation. However, eye-tracking data indicated that autistic adolescents comprehended speech-only input more quickly than their non-autistic peers. Both groups displayed similar patterns of eye movements, but the autistic group fixated on the target faster than the non-autistic group during unimodal, speech-only trials. When presented with speech and gesture input, the non-autistic group was able to integrate the information quickly, evidenced by rapid fixation on the target. The non-autistic group's fixation on the target in the speech and gesture condition was faster than the non-autistic group’s performance in the speech-only condition. Thus, Silverman et al. concluded that comprehension was aided by iconic gestures for the non-autistic group; however, the autistic group had a slower rate of comprehension, corresponding to delayed fixations to the target, when two modalities were presented (Silverman et al., 2010).

Group differences and similarities between autistic and non-autistic individuals have been identified in adults as well. A study including verbally-fluent autistic and non-autistic adults documented the semantic, pragmatic, and motoric features of spontaneous co-speech gestures during a referential communication task (de Marchena et al., 2019). This referential communication task was developed by psycholinguists to allow for controlled yet naturalistic
communication. In the study, conversation partners completed a reciprocal communication task to achieve a shared goal. The participants sat opposite to one another, each with a laptop facing them. One communication partner was shown a figure in which eight abstract figures were organized into a 2 x 4 grid. The other participant was given an empty grid with the same eight abstract figures scattered randomly outside of the grid. The goal was to make the empty grid match the completed grid without showing each other their screens. Each session was recorded. Following the experiment, the video recordings were reviewed, and coders identified and categorized the gestures that the participants produced. The coders categorized the semantic and pragmatic features of each gesture based on three features: gesture type, whether the gesture provided additional information not present in speech, and the coder’s confidence in their own decision about the gesture’s purpose. The task was also reviewed for accuracy in achieving the target goal of all eight figures being placed into the correct location on the formerly blank chart.

De Marchena et al. (2019) revealed that gesture frequency was similar between the groups. Task accuracy was also consistent between the groups. Group differences were found in the form of the gestures. Autistic adults were more likely to produce unilateral gestures (gestures produced with one arm or hand) when compared to the non-autistic group, who were equally likely to use bilateral and unilateral gestures. The autistic adults also differed in their functional use of co-speech gestures; they produced gestures to aid in conversational turn-taking. Examples of these include gestures that signal that the speaker is not done speaking (e.g., holding an index finger up to communicate “don’t interrupt me” or “let me finish”) and gestures that signal the conversational partner is welcome to speak (e.g., an outstretched hand with the palm facing upwards to communicate “go ahead” or “what do you think?”). While the autistic group had similar task accuracy performance and produced a similar quantity of gestures, a significantly
greater amount of their gestures was coded as “other” by non-autistic raters. The autistic adults’ verbal and nonverbal communication was effective, evidenced by their task completion accuracy; however, non-autistic raters struggled to interpret and categorize many of them (de Marchena et al., 2019).

Cairney et al. (2023) examined gesture processing in autistic and non-autistic adults using 108 iconic and 54 nonsense gestures. Prolific was used for participant online recruitment and experiment administration. The study included 114 autistic adults and 81 non-autistic adults. During the task, each participant viewed videos of 36 iconic gestures and 18 nonsense gestures. After viewing each video, the participants were required to answer two questions. First, they were asked to rate the meaningfulness of the gesture using a rating scale. Then, they were instructed to type one word to describe the gesture depicted in the video. The researchers examined meaningfulness ratings from the rating scale. When analyzing the written responses, the following values were calculated: diversity scores, entropy scores, and semantic similarity scores. Diversity scores indicate the variety and distinctiveness among responses. Entropy scores indicate how predictable a particular response is for certain stimuli (Cairney et al., 2023). Higher entropy scores indicate more competition among responses, while lower entropy indicates greater consensus among responses. Semantic similarity indicates how closely related in meaning the unique responses are for a given stimulus. Higher semantic similarity indicates that the responses are more related, while lower semantic similarity means the responses are less semantically related. The findings indicated no significant group differences in the meaningfulness scores. Both groups rated iconic gestures as more meaningful than nonsense gestures. When analyzing the written responses, Cairney et al. found that nonsense gestures elicited a wider variety of labels than did the iconic gestures, indicating more variation in
participants perceptions of these gesture’s meaning. Additionally, the autistic participants responded with a more diverse range of gesture labels when compared to the non-autistic group. Despite this difference, Cairney et al. (2023) found both groups responded with semantically similar labels to the gestures. Both groups were also consistent with having a higher semantic similarity for iconic gestures than nonsense gestures.

Overall, the results indicated that both groups had similar perceptions about the meaning of the gesture stimuli. Despite this, the autistic group provided a greater variety of labels, suggesting more variability in word choice despite perceiving similar meanings. Cairney et al. (2023) noted that this is an example of a feature of autism. They note that bookish and pedantic speech is often observed among autistic adults. This quality of language potentially contributed to the more unique and varied responses among the autistic participants.

Learning and metacognition

Metacognition and learning are intricately linked as metacognitive strategies play a critical role in the improvement of learning outcomes. Metacognition refers to the conscious reflection on and control of one’s own cognitive processes (Flavell, 1979). Metacognitive awareness allows individuals to understand their own learning processes and weaknesses, which can improve their overall learning experience (Metcalf, 2009). An individual’s confidence in their metacognitive judgements will cause alterations in selected learning strategies and their execution of a given task (Efklides, 2014; Huff & Nietfeld, 2009; Jersakova et al., 2017).

Metacognitive monitoring can be indexed by using confidence ratings (judgements of confidence; JOC) and judgements of learning (JOL). Judgments of learning is one's prediction of their own ability to recall taught/studied items (Ariel & Dunlosky, 2011). A variety of terms are used for judgements of learning, but this paper will use JOLs. Often, JOL is measured by having
participants study novel information (e.g., a word pair) and then rate their judgement of their ability to recall the newly taught information at a later point. Thus, JOLs index prospective metacognitive ratings. In contrast, confidence ratings involve a participant answering questions, often related to previously taught information, and then rating their confidence in the accuracy of each answer (i.e., highly confident, moderately confident, not confident/guessing).

A person’s metacognitive judgements and the confidence one has in them impact task executions and the selection of learning approaches. Furthermore, a person’s motivation to learn is impacted by confidence (Keller, 1987). There appears to be a direct relationship between confidence and the effort one is willing to invest in learning (Bandura, 1977). An individual’s confidence in their ability to learn a particular subject matter or and grow in a skill set influences the extend to which they are more motivated to spend time and energy on that endeavor (Bandura, 1977). However, inflated judgements of learning may result in decreased study time and lower recall of studied material (Dunlosky & Rawson, 2012). Some researchers suggest that an individual’s confidence in their metacognitive monitoring, by providing themselves with internal feedback, may fill the role of external feedback (Hainguerlot et al., 2018).

Hainguerlot et al. (2018) found that higher JOL ratings in one’s responses resulted in greater learning and performance as compared to those who were less confident in their JOLs. While confidence and learning seem to have a direct relationship, what happens when an individual’s confidence is inflated due to inaccuracies in their metacognitive monitoring? Understanding the impact of an individual’s confidence, it is important to also consider not only JOLs but also JOCs. When an individual’s JOC does not reflect accuracy on the tested item, this inflated JOC actually increases the saliency of the error following feedback (Butterfield & Metcalfe, 2001). This is called the hypercorrection effect. When feedback is presented, this false
confidence results in the item being more memorable to the learner. However, high levels of confidence alone, especially in the absence of feedback, are not enough to be beneficial to the learner (Dunlosky & Rawson, 2012). Referring back to the relationship between confidence and one's willingness to invest time and energy into a task, this accuracy is extremely important. This mainly relies on ones JOL. When someone is able to accurately make these metacognitive judgements, they are better able to effectively distribute their available cognitive resources and effort (Hainguerlot et al., 2018).

In 2020, Myers et al. conducted a study to further understand how JOLs benefit memory depending on the type of recall test given. Findings indicated cued recall was more beneficial for related word pairs than unrelated word pairs. Additionally, participants who made JOLs exhibited higher recall, though this was not a significant difference when compared to those who did not make JOLs. JOLs specifically improved cued recall of related pairs, while only slightly improving cued recall of unrelated word pairs (Myers et al., 2020).

Zhang and colleagues (2019) examined confidence ratings that were made immediately after a participant answered a test/practice question and its relationship with retrieval practice. Zhang et al. found that the benefits of retrieval practice were linked to the subjects’ confidence in their retrieval accuracy. Items that were correctly recalled in the first recall task were more likely to be retained if subjects rated their confidence above 56% (slightly above chance). High-confidence responses were correlated with the retention of correct responses on the final test (Zhang et al., 2019). While this reinforced earlier research regarding high confidence trials (Butler et al., 2008; Fazio et al., 2010), Zhang and colleagues were able to show the specific importance of confidence in relation to retrieval practice using low-confidence trials. Successful retrieval alone did not seem to be enough, as evidenced by the lack of correct answer retention in
low-confidence retrieval trials (Zhang et al., 2019). Even when a participant initially answered correctly, low confidence ratings in this answer corresponded to the decreased likelihood of a correct response on the final test for that item (Zhang et al., 2019).

**Metacognition and autism**

Current research does not indicate consistent findings regarding the metacognitive abilities of autistic people. As autism is a spectrum including a variety of presentations, it is reasonable to expect that a variety of findings would exist within this population. Wojcik et al. (2014) reported similar performance in autistic and non-autistic children with making JOLs and allocating appropriate study time to learn challenging information. This finding indicated that autistic individuals have intact metacognition and act appropriately on this. However, multiple studies have suggested that autistic participants exhibit metacognitive deficits. These include reports of inflated judgements of learning (Brosnan et al., 2015) and more misalignment of judgements of confidence with test performance in the autistic groups when compared to non-autistic counterparts (Grainger et al., 2016; McMahon et al., 2016; Williams et al., 2016). Wilkinson et al. (2010) found that non-autistic children’s JOC aligned with their performance accuracy on facial recognition tasks, while autistic participants’ JOCs were not consistently or accurately related to their task performance. However, some studies do not support these findings. Sawyer et al. (2014) found that the accuracy of answers compared to elicited judgements of confidence was similar in autistic and non-autistic participants.

Cairney, Lucas, and Haebig. (2024) investigated whether there are group differences in the metacognitive abilities of autistic and non-autistic adults. Both groups of participants were presented with two blocks that consisted of 3 phases each- learning, cued recall, and a second cued recall. Feedback was provided in the cued recall phase for one block, and no feedback was
provided in the other block. In the learning phase, a still image of a person was presented along
with audio of two unrelated words. Following the presentation of the word pair, the participant
was asked to provide a JOL on a sliding scale. After being taught 14 word-pairs and providing
JOLs, the participants completed a distractor task (simple math problems). Next, the cued recall
phase served as an initial test of the word-pairs wherein the first word was presented auditorily
and the participant was asked to type the second word. Following each response, the participant
was prompted to provide a JOC. During the feedback block, participants were then presented
with feedback, in which the word-pair was presented auditorily. Then, there was another
distractor task (simple math problems), which was followed by the second cued recall portion.
The second cued recall phase followed the same process as the first cued recall phase, but across
both conditions, no feedback was provided.

Cairney, Lucas, and Haebig (2024) demonstrated that there was a high correlation
between confidence and accuracy for both groups. Additionally, both groups benefitted from
feedback, with higher cued recall accuracy in the second recall task for both groups when
feedback had been provided. Interestingly, the autistic group had higher levels of recall accuracy
in the second test. These metacognitive processes regarding feedback, accuracy, and confidence
proved to be relatively consistent between the groups. This suggests that these metacognitive
features and their effects on learning are intact and appropriate in autistic individuals.

Grainger et al. (2016) investigated the abilities of autistic adults and adolescents when
making metacognitive judgements, focusing on JOLs. This study consisted of two experiments.
In the first experiment, participants were presented with noun pairs during a study phase.
Following this, the participants were presented with one word of the pairs and instructed to
provide a JOL, indicating their predicted likelihood that they would be able to recall the second
word later in the experiment. During the recall phase, participants were provided with a stimulus cue (one word of the pair) and instructed to recall the missing half of the pair. Results of this experiment revealed that the autistic group recalled significantly fewer target words; however, it was concluded that JOL accuracy was intact in the autistic group. In the second experiment, when asked to provide JOLs, the participants were presented with both words of the pairs rather than just the first word of the pair for half of the presented words. This removes the ability to self-test whether or not they actually remember the other half of the pair. The other half of the presented targets were presented with only the first word, as it had been presented in the first experiment. Findings revealed that the autistic and non-autistic adolescents presented with similar patterns and rates of recall. Additionally, the study found no significant differences between both groups of participants in regard to the rate and patterns of metacognitive performance on JOL tasks.

**Current study**

This study explores cross-modality and associative learning in autistic and non-autistic adults. The research aims consider the impact of gestures and autism on learning and memory. The current study expands on the third experiment conducted by Cairney, West et al. (2024), by adding an autistic group and by focusing on perceived learning (JOLs) instead of imageability. Thus, the first question asks, do iconic gestures promote learning and memory of word pairs, and do they influence learning differently between autistic and non-autistic adults? Second, do adults perceive learning (JOLs) differently when a gesture is provided with a word pair versus when it is not and are there differences in group JOLs across gesture conditions? Based on the information provided in the literature review, I hypothesize that iconic gestures will promote learning and memory. Furthermore, I predict that non-autistic adults may benefit more from the
addition of iconic gestures to this task, relative to the autistic adults. However, when gestures are not present, I predict that autistic adults may perform better than their non-autistic counterparts.
Chapter 2. Methods

Participants

Participants included 40 autistic adults and 40 non-autistic adults between 18 and 35 years of age whose first acquired and primary language was American English. Recruitment and data collection took place on an online recruitment platform, Prolific (https://prolific.com). This platform required its users to complete profiles that can then be used by experimenters to identify desired samples. This profile included a self-reported autism diagnosis status. We did not exclude participants with other existing psychiatric diagnoses. See Table 2.1 for participant characteristics.
Table 2.1. Participant characteristics

<table>
<thead>
<tr>
<th></th>
<th>Autistic ($n = 40$)</th>
<th>Non-Autistic ($n = 40$)</th>
</tr>
</thead>
</table>
| **Age (years)**          | $M = 27.60$  
$SD = 4.60$  
Range: 20 – 35                                                                 | $M = 28.08$  
$SD = 4.80$  
Range: 18 - 35                                                                 |
| **Gender**               | Male ($n = 25$)  
Female ($n = 14$)  
Non-Binary ($n = 1$)                                                                 | Male ($n = 18$)  
Female ($n = 20$)  
Non-Binary ($n = 2$)                                                                 |
| **Race**                 | White ($n = 27$)  
Black or African American ($n = 6$)  
American Indian or Alaska Native ($n = 1$)  
Asian ($n = 2$)  
Multiple Races ($n = 3$)  
Not disclosed ($n = 1$)                                                                 | White ($n = 23$)  
Black or African American ($n = 12$)  
American Indian or Alaska Native ($n = 0$)  
Asian ($n = 2$)  
Multiple Races ($n = 3$)  
Not disclosed ($n = 0$)                                                                 |
| **Ethnicity**            | Hispanic/Latino/a/e ($n = 5$)                                                                 | Hispanic/Latino/a/e ($n = 1$)                                                                 |
| **Highest Level of**     | PhD/Doctoral degree ($n = 1$)  
Master’s degree ($n = 5$)  
Bachelor’s degree ($n = 8$)  
Associate’s degree ($n = 4$)  
Some College ($n = 14$)  
High School Degree/GED ($n = 8$)                                                                 | PhD/Doctoral degree ($n = 0$)  
Master’s degree ($n = 4$)  
Bachelor’s degree ($n = 9$)  
Associate’s degree ($n = 6$)  
Some College ($n = 12$)  
High School Degree/GED ($n = 9$)                                                                 |
Stimuli

Stimuli consisted of 64 videos (4 practice items, 6 buffer items, and 54 trial items) that were 8 seconds in length. Thirty-two of these videos are presented with an iconic gesture and the remaining 32 are presented without a gesture. These videos and word pairs were created and standardized by Cairney et al. (2023). The videos include a spoken sentence that included a present progressive verb paired with a noun at the end of the sentence frame (e.g., “He thought about the typing flower”). In the no-gesture condition videos, a spoken sentence is played while a model remains still; the model is a female young adult who is seated and whose head and lower legs are not visible. The videos for stimuli in the gesture condition have the same spoken sentences, but they are played over a video including an iconic gesture that is synched with and semantically matched to the predicate that is presented as the second to last word in the sentence (i.e., word 1 of the word pair). Thus, there are a total of 128 stimuli videos used in the experiment, 64 with gestures and 64 without gestures. Two versions of the experiment (version A and version B) were created to counterbalance the condition in which each word pair was presented. Word pairs presented with gestures in version A were presented without gestures in version B and vice versa. Additionally, word pairs were matched based on meaningfulness scores of the iconic gesture (reported in Cairney et al., 2023) between condition, and across blocks. Meaningfulness scores were not statistically different for gesture word pairs and no-gesture word pairs both across blocks and within blocks ($p = 0.79$ and $p = 0.66$, respectively).

Pre-screening

Prolific employs a filtering mechanism to screen out participants who do not meet the study’s predefined criteria. The eligibility of participants was determined based on the demographics they had previously reported to Prolific. The study was exclusively advertised to and accessible
to individuals whose demographic information aligns with the researchers’ pre-specified criteria, ensuring a targeted and relevant participant pool. For this experiment, participants’ Prolific demographics information needed to report them to be autistic or non-autistic (depending on the designated group), located in the United States, between the ages of 18 and 35 years, and speak English as their first or primary language. Participants from previous Cairney et al. studies that included these stimuli were excluded.

As an additional layer of security, we included three pre-screening questions that participants were required to answer before being shown the consent form. The first question asked about autism diagnostic status. Participants for the autistic group were routed out of the experiment if they indicated that they did not have an official autism diagnosis; participants for the non-autistic group were routed out of the experiment if they indicated that they did have an autism diagnosis, identified as autistic, or were in the process of being evaluated for autism. The subsequent two screening questions asked about English proficiency and fluency in American Sign Language (ASL) or Signing Exact English (SEE). Participants were excluded if they indicated that English was not their primary or first language. Participants were also excluded if they indicated they were fluent in SEE or ASL. Additionally, after consenting to participate in the study, the participant was asked to agree to an honesty statement, agreeing to complete the task without any external memory aids (e.g., taking notes).

**Procedure**

Once a participant indicated that they wanted to participate in the study, Prolific directed them to Qualtrics (www.qualtrics.com). Participants first responded to pre-screening questions, described above, and then were presented with the consent form and then honesty statement. Next, task instructions and a brief practice block was presented. The practice block included a sample video
and then a reminder of the two words that the participant was supposed to attempt to remember. Then, three additional practice items were presented, followed by a practice recall test with feedback. The stimuli used in the practice block was not repeated in other blocks.

Following the practice block, the main experimental phases began. The experiment structure included three phases within a block – a learning phase, distractor task, and test phase. These phases are outlined below in Figure 2.1. The first phase contained a learning phase, where participants were presented with 20 videos (ten from each condition, presented in a randomized order), two of the videos were pre-selected to serve as “buffer trials”. One buffer trial was presented at the beginning and one at the end of each block to control for primacy and recency effects. The buffer items were not included in the analysis of recall targets and their JOLs were not analyzed. Each trial within the learning phase lasted 20 seconds; the task advanced to the next trial automatically after 20 seconds. During a trial within the learning block, the participants were instructed to click on the video to begin playing it. Each eight second a video presented the word pair in the context of a spoken sentence. The second to last word in the sentence was accompanied by either a still video of an actor who was sitting (no gesture condition) or a video with an actor who was producing an iconic gesture that aligned in meaning with the spoken word (gesture condition). The second word in the word-pair was spoken as the last word of the sentence while the actor remained still on screen. After the video completed, the participants were supposed to use a sliding scale (0 – 100) to mark the participant’s judgement of learning (exact prompt: “How likely are you to remember this word pair?”). For each trial item, the text, “Drag the slider between 0 (not confident at all) and 100 (very highly confident)” appeared next to the sliding bar. Each block included a randomly presented attention check of a still, silent video in which text appeared asking participants to slide the JOL bar to 100. The second phase
included ten simple math problems; completion of this distraction phase was self-paced. Finally, the third phase consisted of a free recall test, in which the participants were instructed to type as many word pairs as they could remember or single words if they cannot remember the full pair. The instructions directed the participant to type pairs on one line together, then click enter to start a new line for each new word pair they recall. There was no time limit for the test blocks.

In the last component of the task, the participants completed a short demographics form and answered questions about the experiment. The demographics section asked for information about the participant's age, birth month, birth year, gender, race, and highest education level. Participants were given the option to include comments about gender identity, education level, and race or ethnicity. Additionally, participants were asked four post-experiment questions asking about technical difficulties, memory strategies, use of external memory aids, and if the instructions were clear. The experiment was expected to take approximately 45 minutes to complete. The median completion time was approximately 40 minutes across both groups. Participants were compensated $11.25, a compensation rate of approximately $16.85 per hour.

Figure 2.1. Phase structure
Analysis Plan

A repeated measures mixed analysis of variance (ANOVA) was used to evaluate recall accuracy between the learning conditions and groups; the number of words that were accurately recalled was the dependent variable, and the independent variables included condition (iconic gesture vs. no gesture), group (autistic vs. non-autistic), and interaction between condition and group. Three separate ANOVAs examined the following dependent variables: word one recall, word two recall, and recall of word pairs. To address the second research question, we conducted a repeated measures mixed ANOVA; the dependent variable was averaged JOLs for each condition for each participant, and the independent variables included condition (iconic gesture vs. no gesture), group (autistic vs. non-autistic), and an interaction between condition and group.
Chapter 3. Results

RQ1: Do iconic gestures promote learning and memory of word pairs, and do they influence learning differently between autistic and non-autistic adults?

W1 Recall Findings

When analyzing W1 recall, there was a main effect of condition with a medium effect size, $F(1, 78) = 28.26, \ p < 0.001, \ \eta^2_p = 0.060$, indicating that W1s that were presented in the gesture condition were recalled more accurately than those presented in the no-gesture condition. There was no main effect of group and there was no significant interaction between group and condition. See Table 3.1 for full model output. As displayed in Figure 3.1, both groups demonstrated a consistent pattern for W1 recall.

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>$F$</th>
<th>$\eta^2_p$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>1</td>
<td>0.25</td>
<td>0.003</td>
<td>0.616</td>
</tr>
<tr>
<td>Condition</td>
<td>1</td>
<td>28.26</td>
<td>0.060</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Condition: Group</td>
<td>1</td>
<td>2.75</td>
<td>0.006</td>
<td>0.101</td>
</tr>
</tbody>
</table>
W2 Recall Findings

Although W2 recall means were higher in the gesture condition, our analyses revealed that the effect of condition was not significant, $F(1, 78) = 1.98, p = 0.164, \eta^2_p = 0.004$. There was no main effect of group, and there was no significant interaction between group and condition. See Table 3.2 for full model output. While iconic gestures marginally improved learning and memory of W2, there were no significant performance differences between autistic and non-autistic participants, as shown in Figure 3.2.
Table 3.2. W2 recall

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>F</th>
<th>$\eta_G^2$</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>1</td>
<td>0.36</td>
<td>0.004</td>
<td>0.551</td>
</tr>
<tr>
<td>Condition</td>
<td>1</td>
<td>1.98</td>
<td>0.004</td>
<td>0.164</td>
</tr>
<tr>
<td>Condition: Group</td>
<td>1</td>
<td>0.89</td>
<td>0.002</td>
<td>0.351</td>
</tr>
</tbody>
</table>

Word Pair Recall Findings

When examining the word pairs, our analysis revealed a main effect of condition with a small effect size, $F(1, 78) = 10.44, p = 0.002, \eta_G^2 = 0.017$. The analysis yielded no significant
effect by group, indicating similar performance across both groups. There also was no significant group by condition interaction. See Table 3.3 for full model output. Iconic gestures improved word pair recall with no significant difference between autistic and non-autistic participants, as depicted in Figure 3.3.

Table 3.3. Word pair recall

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>F</th>
<th>$\eta^2$</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>1</td>
<td>0.24</td>
<td>0.003</td>
<td>0.625</td>
</tr>
<tr>
<td>Condition</td>
<td>1</td>
<td>10.44</td>
<td>0.017</td>
<td>0.002</td>
</tr>
<tr>
<td>Condition: Group</td>
<td>1</td>
<td>2.40</td>
<td>0.004</td>
<td>0.126</td>
</tr>
</tbody>
</table>

Figure 3.3. Word pair recall
RQ2: Do adults perceive learning (JOLs) differently when a gesture is provided with a word pair versus when it is not and are there differences in group JOLs across gesture conditions?

JOL Findings

There was a main effect of condition with a small effect size, $F(1, 78) = 19.72, p = < 0.001, \eta^2_g = 0.008$, indicating that JOLs were higher in the gesture condition as depicted in Figure 3.4. Results show no main effect of group and no group by condition interaction. See Table 3.4 for full model output. Overall, JOLs and recall accuracy were greater in the gesture condition.

<table>
<thead>
<tr>
<th></th>
<th>df</th>
<th>F</th>
<th>$\eta^2_g$</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>1</td>
<td>0.33</td>
<td>0.004</td>
<td>0.568</td>
</tr>
<tr>
<td>Condition</td>
<td>1</td>
<td>19.72</td>
<td>0.008</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Condition: Group</td>
<td>1</td>
<td>0.00</td>
<td>&lt; 0.001</td>
<td>0.954</td>
</tr>
</tbody>
</table>
Figure 3.4. Judgements of learning
Chapter 4. Discussion

The current study provides valuable insights into the impact of iconic gestures on word pair recall and metacognitive judgements of learning in autistic and non-autistic adults. Prior to this study, the available data regarding gesture production, and particularly on gesture processing, among autistic individuals report mixed findings. Furthermore, this line of research is often focused on studying autistic children rather than autistic adults. The current study expands on the work of Cairney et al. (2023). While Cairney et al. (2023) examined gesture processing in autistic and non-autistic adults by analyzing responses to iconic and nonsense gestures, we examined the potential facilitatory effect of viewing a gesture while hearing word pairs that were to be memorized. In the current study, we found that, relative to the no gesture condition, iconic gestures that semantically matched the W1 were associated with more successful learning and memory of W1 and the word pair for both groups. Relatedly, autistic and non-autistic adults perceived this facilitation effect, as evidenced by both groups providing higher judgments of learning for word pairs that were presented with gestures.

Our finding that W1 recall benefitted from iconic gestures aligns with prior work examining iconic gestures in non-autistic adults (Cairney, West, et al., 2024). The current study extended this finding to autistic adults; gestures enhance recall in this context irrespective of autism diagnostic status. This improvement of item memory in the gesture condition aligns with other earlier studies on the influence of iconic gestures on word recall in non-autistic adults (Riseborough, 1981; Sánchez-Borges & Álvarez, 2023). Furthermore, our finding complements the Cairney et al. (2023) gesture processing study, which found that autistic and non-autistic adults perceived iconic gestures to be meaningful. Interestingly, Cairney et al. (2023) found that in free-response data, autistic adults provided more diverse terms to describe each iconic gesture.
Despite these more diverse terms, the semantic content was similar between both groups. Our findings support the semantic alignment finding presented by Cairney et al. (2023) because processing of the iconic gesture that was accompanied by a specific word (e.g., locking gesture with the auditory presentation of the word “locking”) was recalled to a similar extent in both groups. Had the autistic individuals perceived the iconic gestures as a mismatch to the spoken label, we may have seen differences in our W1 recall data. Thus, the current findings and the Cairney, West et al. (2024) findings suggest similar iconic gesture processing between autistic and non-autistic individuals.

Next, the current W2 recall results revealed that mean W2 recall accuracy was higher in the gesture condition; however, this effect was not significant, $p = 0.164$, $\eta^2_p = 0.004$. In observing group means, it was notable that participants recalled more W2s than W1s and this pattern was stronger in the no gesture condition. It is possible that the concreteness of the nouns (W2s) facilitated this effect, especially given that the predicates that were not accompanied by a gesture were likely less concrete relative to the predicates that co-occurred with gestures (serving as concretizers for the W1s). Similar to the results of W1 recall analysis, no significant group effect was shown between or within participants, demonstrating consistent performance between autistic and non-autistic participants. In contrast, Cairney, West et al. (2024) found that W2 recall was higher in the gesture condition relative to the no gesture condition in their third experiment. In Cairney, West et al.’s (2024) gesture and memory study, the authors discuss the dual coding theory and the associative memory benefits of concreteness (Paivio, 1965). They explain that concrete words elicit clearer mental pictures, which function as “conceptual pegs” from which additional words can be “hung”, sharing the memory benefits. Cairney, West et al. (2024) suggest that the addition of iconic gestures may increase imageability and concreteness of
W1, which may allow for W2 to reap the associative memory benefits, evidenced by enhanced W2 recall in the gesture condition. In Cairney, West et al.’s third experiment, the presence of iconic gestures resulted in higher imageability and associative memory benefits (Cairney, West, et al., 2024). While Cairney, West et al. (2024) identified a significant effect size for condition on W2 recall, the current study did not exhibit such notable differences between conditions. In Cairney, West et al.’s three experiments (2024), participants were explicitly instructed to try to generate mental images of the word pairs. In doing so, this may have led to more elaborative encoding overall, which may have strengthened the associative memory effect for W2. This W2 finding was not really replicated in the current study. This could be related to the differing instructions given as participants were not told to create a mental picture of the word pairs. However, although marginal, there appeared to be a trend in the same direction, similar to the W2 finding in the first experiment in Cairney, West et al. (2024), which included a beat gesture in addition to iconic gesture and no gesture conditions.

Findings related to word pair recall further reinforce the benefit of iconic gestures on memory. Consistent with W1 and W2 recall results, there was no main effect of group and no significant group by condition interaction. While the effect size observed for the condition effect on word pair recall ($\eta^2_6 = 0.017$) is not as large as that of W1 recall, it still indicates that gestures enhance overall word pair recall. Cairney, West et al. (2024) also found that word pair recall was higher in the gesture condition relative to the no gesture condition in their first and third experiments.

The absence of group effect across W1, W2, and word pair recall accuracy aligns with the aforementioned gesture processing findings from Cairney et al. (2023), which revealed that autistic and non-autistic adults perceived iconic gestures to be meaningful. In the current study,
participants demonstrated similar patterns of benefit or lack of benefit for word recall respective
to each condition. The recall enhancement provided by the presence of iconic gestures was
shared by both autistic and non-autistic participant groups, further supporting similar gesture
processing. Similarly, Silverman et al. (2010) found that autistic and non-autistic adolescents
exhibited no significant differences in decoding iconic gestures that were presented in isolation
(however, gestures were found to reduce the rate at which autistic adolescents were able to
process spoken language). The current study’s gesture processing findings also align with some
of the gesture production findings. For instance, de Marchena et al. (2019) found that gesture
production frequency and efficacy were similar between autistic and non-autistic participants,
though differences were identified in form (laterality) and intended function.

Moving into the results of JOL analysis, participants exhibited higher JOLs for word
pairs presented with gestures compared to those taught without gestures. Word pair recall
accuracy and JOLs demonstrated significant condition effects, showing increased measures in
the gesture condition, across both groups. Participants on average reported lower JOLs for the no
gesture condition, accurately aligning with lower levels of recall accuracy. This is similar to what
Cairney, Lucas, and Haebig (2024) found regarding confidence ratings and accuracy. They found
that JOCs (ratings of confidence in responses that were provided during a test) and accuracy
were highly correlated, suggesting accurate metacognitive monitoring. Additionally, Cairney,
Lucas, and Haebig (2024) found that the only group difference was a higher recall accuracy for
the autistic group. In the current study, no group effects were present for JOLs and there was no
group difference for recall accuracy. Here, JOLs aligning with higher and lower accuracy
between conditions suggests similar metacognitive abilities between the two groups. This finding
is consistent with the literature that claims autistic individuals have intact metacognition and awareness (Sawyer et al., 2014; Wojcik et al., 2011, 2014).

**Directions for future research**

While this study has identified key findings addressing its research questions, further analysis of participant responses could yield valuable insight into potential error patterns. Analysis of responses that were “intrusions” – words that were not presented in the learning phase – could provide additional insight into learning and memory in both groups. Some of the intrusion responses were close to the target words phonologically or semantically, while some displayed no clear similarities. Additionally, intrusions from previous blocks were also observed across many participants. This type of intrusion was coded, but not yet analyzed. In the current analysis, participant recall was collapsed across blocks. Analysis of block performance between and within groups may provide more insight into the participants’ recall and fatigue across the experiment.

**Limitations**

While offering valuable insights into the impact of iconic gestures on word pair recall and JOLs, particularly the potential differences between autistic and non-autistic adults, this study acknowledges several limitations which may impact the interpretation and application of the results. The limitations of this study primarily stem from its remote administration via an online platform. While this format theoretically allows for a wider range of participants and increased randomization, it also requires researchers to relinquish control of certain variables.

Participants were only permitted to complete this experiment on a tablet or computer, which was programmed into the experiment settings. Other aspects of the individual’s device, display brightness, internet speed, environment, and audio quality were unable to be regulated.
The post-experiment screener asked participants if they had experienced any technical difficulties to monitor any issues that could have occurred. It was rare, but a few participants reported having an instance of one video not playing \((n = 6)\). This issue was uncommon and was unable to be recreated by experimenters, potentially suggesting issues with the individual’s device or internet connection. Also, the recall accuracy in the current study still need to be reviewed to determine whether any statistical outliers are present in the data.

Furthermore, researchers must rely on participant honesty. To reduce dishonesty, participants were asked to agree to an honesty statement prior to starting the experiment, where they agreed not to use any external memory aids. Participants who declined to agree to this would have been kicked out of the experiment immediately. Additionally, the participant was asked in the post-experiment questionnaire whether or not they had cheated by using external memory aids. It was made clear to participants that their answer to this question would not result in the withholding of payment.

The use of this platform meant that autism diagnostic status was unable to be independently verified. The study forms for autistic participants were only advertised to individuals who had identified as autistic on their Prolific demographics profile and the study forms for non-autistic participants were not advertised to individuals who’d identified themselves as autistic on their profile. Once the participant opened the experiment, multiple screening questions were asked including one regarding the participant’s autism diagnostic status.

Additionally, participants were not asked if they had any form of hearing loss. As this experiment required participants to listen to the spoken sentences, hearing loss could impact the
participants’ ability to complete the task effectively. Further, the experiment should have directed participants to use headphones while completing the task.

Another limitation of this study, particularly in comparison to Cairney, West et al.’s (2024) gesture and memory study, is the lack of non-iconic gestures. Cairney, West et al. were able to analyze the differences between experiments including nonsense and beat gestures. This study only including the iconic gesture condition makes it hard to know the mechanisms of the gesture benefit and whether they are the same in both groups.

Conclusions

The results of this study underscore the ability of iconic gestures to support learning and memory of spoken language. Specifically, recalling word pairs taught in the context of spoken sentences. Viewing iconic gestures that semantically aligned with the first word in the word pair led to improved W1 and word pair recall, and marginally supporting W2 recall. This benefit was observed for both non-autistic and autistic individuals. Moreover, both groups of participants demonstrated increased JOLs for word pairs that were accompanied by iconic gestures, compared to those presented without iconic gestures. This suggests that the presence of iconic gestures increases an individual’s confidence in their ability to learn and recall accompanying word pairs. These JOLs aligned with word pair recall accuracy, indicating consistent metacognitive monitoring across both groups.
## Appendix A. Word Pair Stimuli

<table>
<thead>
<tr>
<th>Word 1</th>
<th>Word 2</th>
<th>Condition &amp; Block</th>
<th>Word 1</th>
<th>Word 2</th>
<th>Condition &amp; Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>growing</td>
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Appendix B. Institutional Review Board Approval

TO: Eileen Haebig
LSUAM | Col of HSS | Communication Sciences and Disorders | CC00127
FROM: Alex Cohen
Chairman, Institutional Review Board
DATE: 19-Mar-2024
RE: IRBAM-22-0394
TITLE: Adult Learning and Memory
New Protocol/Modification/Continuation: Continuation
Review Type: Expedited Review
Risk Factor: Minimal
Review Date: 19-Mar-2024
Status: Approved
Approval Date: 19-Mar-2024
Approval Expiration Date: 27-Mar-2025
Re-review frequency: (annual unless otherwise stated)
Number of subjects approved: 500
LSU Proposal Number:

By: Alex Cohen, Chairman

Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*.
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
8. SPECIAL NOTE: When emailing more than one recipient, make sure you use bcc.

* All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at http://www.lsu.edu/research

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Fax: 225-578-5983
http://www.lsu.edu/research

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Bibliography


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Vita

Caprielle Priola was born in Baton Rouge, Louisiana, and spend her formative years in Lake Charles, Louisiana, and Orange Beach, Alabama, before returning to Baton Rouge. Following high school graduation, Caprielle attended Louisiana State University, where she earned a Bachelor of Arts in Communication Disorders in May 2022. After completing her undergraduate degree, she was admitted to Louisiana State University’s master’s program. During her time in this graduate program, Caprielle worked as a graduate research assistant under Dr. Eileen Haebig in the Language Net Lab. She anticipates graduating with her Master of Arts in Communication Disorders in May 2024. Following her graduation from Louisiana State University, Caprielle plans to begin her clinical fellowship year and pursue licensure as a speech-language pathologist. She aims to work with a diverse range of patients and their families, addressing various disorders and challenges from infancy through adulthood.