DETAILS IN HAND: HOW DOES GESTURING RELATE TO AUTOBIOGRAPHICAL THINKING?

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DETAILS IN HAND: HOW DOES GESTURING RELATE TO AUTOBIOGRAPHICAL THINKING?

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DECLARATION OF ORIGINALITY

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ABSTRACT

Details in Hand: How Does Gesturing Relate to Autobiographical Thinking?

Gestures and speech have different expressive capabilities. When narrating an autobiographical memory, gesturing may reduce the cognitive load of verbal reporting, gestures may function as externalized cues activating episodic details of the memory representation, or gestures might help the construction of event scenes experienced during the original event. Thus, gestures might have a mnemonic role in the retrieval of episodically and phenomenologically rich memories and this potential role might change as a function of age, reflecting the developmental differences in gesturing, memory, and related cognitive systems. Additionally, the use of gestural and verbal modalities, either separately or simultaneously, might vary with age and the episodicity of the information recalled. Using the cue-word technique, 35 children and 46 adults were asked to recall and verbally report six memories, then they rated the recalled memories on three phenomenological properties: visual imagery, spatial imagery, and reliving. Episodic, visuo-motoric and nonepisodic details of autobiographical memories and representational gestures produced during memory narration were coded from video-records. In adult memories, representational gesture production was associated with the recall of more episodic as well as visuo-motoric details, but not with the recall of non-episodic details. However, gesturing did not relate to the phenomenological experience of autobiographical memories via the number of details remembered. When narrating autobiographical events, adults preferred to use gestural and verbal modalities together, whereas children exclusively used the verbal modality. The modality preference of each group was more pronounced when reporting episodic details.

ÖZET

Eldeki Ayrıntılar: Jestler ve Otobiyografik Düşünce Arasında Nasıl Bir İlişki Var?

Jestler ve sözcükler bir mesajı farklı şekillerde iletirler. Otobiyografik bir anıyı anlatırken üretilen temsili jestler; sözlü anlatımının bilişsel yükünü azaltabilir, anıların episodik ayrıntılarını etkinleştirmede ipucu görevi görebilir veya olay sırasında deneyimlenen mekânsal sahnelerinin canlandırılmasına yardımcı olabilir. Dolayısıyla, jestlerin episodik ve fenomenolojik olarak zengin anıların hatırlanmasıyla pozitif yönde bağlantılı olacağı öngörülmektedir. Jest, bellek ve ilgili bilişsel sistemlerdeki gelişimsel farklılıklar nedeniyle, öngörülen bu ilişkinin yaşa bağlı değişim göstermesi de beklenmektedir. Anı anlatımı esnasında jestlerin ve sözel kanalın ayrı ayrı mı yoksa beraber mi kullanıldığı, bu kullanımın yaşa ya da hatırlanan bilginin episodik değerine göre değişip değişmediği de araştırılan bir diğer sorudur. Toplam 35 çocuk ve 46 yetişkinden altı anı hatırlamaları, bunları sözlü olarak bildirmeleri ve hatırlanan anıları görsel imgelem, mekânsal imgelem ve yeniden yaşama hissi üzerinden değerlendirmeleri istendi. Anıların içerdiği episodik, görsel-motorsal ve episodik olmayan detaylar ve anlatım sırasında üretilen temsili jestler video kayıtlarından kodlandı. Bulgular, yetişkin anılarında, hatırlanan episodik ve görsel-motorsal detayların temsili jest üretimi ile pozitif ilişki içinde olduğunu gösterirken episodik olmayan detayların hatırlanmasında jestlerin bir rolünün olmadığını ortaya koydu. Jest kullanımı ve anıların fenomenolojik özellikleri arasında hatırlanan detay miktarının aracılık ettiği bir ilişki bulunamadı. Anı anlatırken yetişkinlerin, jestleri ve sözel kanalı birlikte kullandığı, çocukların ise ağırlıklı olarak sözel kanalı kullandığı gözlemlendi. Her bir grubun kanal tercihinin episodik ayrıntıları bildirirken daha belirgin olduğu da bulunmuştur.

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To Fatih and Çağan,

Couldn’t have done it without your support and patience.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION..…………………………………………………..….1

1.1 Autobiographical memories and their multimodality…………………….…1

1.2 The development of autobiographical memory………………………….….4

1.3 The role of language in autobiographical memory……………………….……6

1.4 Individual differences in gesture use, and the mnemonic function of gestures……………………………………………………….............8

1.5 How could gestures contribute to autobiographical memory...................14

1.6 Gestures and phenomenology of autobiographical memories…………..20

1.7 The use of verbal and gestural modalities in the narration of autobiographical memories……………………………………..……...…22

1.8 The present study……………………………………….………………25

CHAPTER 2: METHOD……………………………………………………………30

2.1 Participants………………………………………………………………30

2.2 Procedure……………………………………………………………..30

2.3 Measures……………………………………………………………...31

2.4 Coding……………………………………………………………...32

2.5 Statistical analyses………………………………………………………35

CHAPTER 3: RESULTS……………………………………………………………37

3.1 Preliminary analyses……………………………………………………37

3.2 Representational gestures and autobiographical memory content………39

3.3 Representational gestures and phenomenology…………………………45

3.4 Modality through which episodic and non-episodic details are reported……………………………………………………………...…50

CHAPTER 4: DISCUSSION……………………………………………………………..53

4.1 Representational gestures and autobiographical memory content…………………………………………………………….....……53

4.2 The mechanism behind the relation between gesturing and autobiographical memory content…………………………………………….57

4.3 Developmental differences in the relation between representational gestures and autobiographical memory content………………………….......59

4.4 Gestures and phenomenology of autobiographical memories…..…....…62

4.5 The use of verbal and gestural modalities in the narration of autobiographical memories……………………………………………...…64

4.6 Limitations and future directions…………………………..…………..67

4.7 Conclusions………………………………………………………..…...68

APPENDIX A: ETHICS COMMITTEE APPROVAL……………………………..69

APPENDIX B: MEMORY CONTENT CODING: NON-EPISODIC DETAIL EXAMPLES……………………………………………………………………...70

APPENDIX C: MEMORY CONTENT CODING: EPISODIC DETAIL EXAMPLES……………………………………………………………………...71

APPENDIX D: SENSITIVITY POWER ANALYSIS PLOT: MODERATION ANALYSES………………………………………………………………………72

APPENDIX E: SENSITIVITY POWER ANALYSIS PLOT: MODERATED MEDIATION ANALYSES……………………………………………………73

APPENDIX F: SENSITIVITY POWER ANALYSIS PLOT: MIXED ANOVA ANALYSIS…………………………………………..…………………...74

APPENDIX G: SUPPLEMENTARY ANALYSES: TOTAL GESTURE………....75

APPENDIX H: SUPPLEMENTARY ANALYSES: NONREPRESENTATIONAL GESTURE…………………………………………………………..……………78

REFERENCES…………………………………………………………………...82

LIST OF TABLES

Table 1. Phenomenological Properties Rated by the Participants………………….32

Table 2. Descriptive Statistics for Study Variables……………………………...37

Table 3. Bivariate Relations among Study Variables………………………………41

Table 4. Age as a Moderator in the Relation between Representational Gesture and Memory Content……………………………………………………………42

Table 5. Testing the Moderated Mediating Effect of Representational Gesture on Visual Imagery………………………………………………………………48

Table 6. Testing the Moderated Mediating Effect of Representational Gesture on Spatial Imagery…………………………………………...……………48

Table 7. Testing the Moderated Mediating Effect of Representational Gesture on Reliving…………………………………………………………………...49

CHAPTER 1

INTRODUCTION

People frequently make hand gestures while talking in general, and also when talking about past events, presumably to convey some of the imagistic content specific to the event being discussed. For example, narrating a multimodal summer vacation memory that includes, but is not limited to, the general view of the seaside, the smell of the moss nearby, the taste of the ice cream being eaten, the cramp one had in her leg, the sound of the laughters around, the actions being engaged in as well as the these actions' temporal sequence, the joy one feels, semantic information about summer vacations and the memories of previous vacations- would be cumbersome without gestures. Since gesture conveys meaning differently than speech, two modalities can represent multiple pathways into autobiographical thinking when combined. Gestures, as McNeill (1992) points out, convey meanings holistically, depending on idiosyncratic images created by speakers at the time of speaking. Speech, on the other hand, uses socially codified words and grammatical structures to convey meanings in a linear, segmented manner (Alibali et al., 2009; Goldin-Meadow, 2003; Kelly et al., 2002; Novack & Goldin-Meadow, 2015, 2017). The aim of this study was to examine how gesture and speech function together in delivering an autobiographical memory containing information from multiple modalities; this question has not received much research attention to date.

1.1 Autobiographical memories and their multimodality

Autobiographical memories are declarative, explicit memories of previously experienced events remembered with a sense of reliving from the specific viewpoint of the self (Fivush, 2011; Greenberg & Rubin, 2003; Nelson & Fivush, 2004). Events remembered as autobiographical memories typically involve episodic information that directly relate to evens such as time, place, actions, objects, perceptual states, emotions, cognitive states as well as non-episodic information such as details from other external events, general facts, extended events, and metacognitive statements (Levine et al., 2002; Strikwerda-Brown et al., 2019). Autobiographical memories are considered to be the product of a complex (re)construction process (Anderson & Conway, 1993; Bartoli & Smorti, 2019; Conway et al., 2002; Conway & Rubin, 1993; Hassabis et al., 2007; McClelland, 2011; Rubin, 2005; Schacter & Addis, 2007). Basic memory systems, imagery, language, narrative comprehension/production, temporal understanding, self representation, and emotion are all thought to have a role in autobiographical memory retrieval (Greenberg & Rubin, 2003; Howe et al., 2003; Nelson & Fivush, 2004; Picard et al., 2009; Rubin, 2005).

How do these diverse processes work together to create autobiographical memories? Several theories, namely the scene construction theory and the constructive event simulation theory, claim that scene construction, or the capacity to internally create and maintain a highly complex and coherent scene when it is not visible, underpins autobiographical memory as well as other high-level cognitive functions like imagination, navigation, problem solving, planning, and creativity (Hassabis & Maguire, 2007; Mullally et al., 2012; Schacter & Addis, 2007; Sheldon & Levine, 2016). When recalling personal past events, a scene is generated to package information; once these scenes are created, then multimodal descriptions of the event are integrated into a cohesive whole (Hassabis et al., 2007). This is accomplished by reactivating, recalling, and integrating relevant semantic, contextual, and sensorial components that are kept in their modality-specific cortical regions (Hassabis et al., 2007; Wheeler et al., 2000). Scene construction is critical for autobiographical memory for several reasons. For example, episodic reconstruction is highly adaptive for future planning since it allows people to rely on past experiences that may happen in the future (Schacter & Addis, 2007). This type of reconstructive storage also facilitates abstraction and generalization across different experiences (McClelland et al., 1995).

The hippocampus and surrounding cortices, amygdala, retrosplenial cortex, posterior parietal regions, visual cortex, and lateral and medial prefrontal cortex all work together to retrieve autobiographical memories, corroborating that autobiographical memories are multimodal (Conway et al., 2002; Maguire, 2001; Nadel et al., 2000; Rubin, 2005; Svoboda et al., 2006). The synchronized activity of these diverse cortical areas creates the experience of a coherent event; indeed, retrieval is achieved by the same circuits that were engaged in the event's initial encoding (Bauer, 2015). Among these cortical regions, the hippocampus supports the construction and use of complex high-resolution bindings that attach the qualitative features of an event; these bindings are crucial for recollection and can also benefit performance on other cognitive tasks such as perception and working memory (Davachi, 2006; Eichenbaum, 2004; Yonelinas, 2013). Thus, hippocampus enables long-term retention of the co-occurrences of people, places, and objects, including their spatial, temporal, and interactional connections (Konkel & Cohen, 2009), as well as representations of connections among different events over time, providing a basis for the greater record of one's personel experiences. Therefore, hippocampus damage or age-related hippocampal reductions are associated with disruptions in the ability to construct highly detailed episodic records of past events

(Eichenbaum, 2004; Kurczek et al., 2015; Race et al., 2011; Turriziani et al., 2008; Yonelinas et al., 1998, 2007).

The representational flexibility, the reconstruction and reassembly of information and its usage in novel contexts is another hallmark trait of the hippocampus (Eichenbaum, 2004). Possibly due to these two features, hippocampus also underlies gesture production. In four discourse tasks, patients with severe hippocampal amnesia were compared to healthy control participants: describing how to prepare their favorite sandwich, recounting Kennedy's assassination, recounting their most terrifying experience, and describing how to shop in a supermarket (Hilverman et al., 2016). Altough amnesic patients and healthy participants reported similar number of episodic details, amnesic patients produced substantially fewer gestures than healthy participants. Moreover, the proportion of episodic features reported in each discourse task predicted gesture rate for healthy participants, but not for amnesic patients (Hilverman et al., 2016). Thus, gestures are supported partly by hippocampal memory representations, and when these representations are impaired, as in amnesic patients, the rate of gestures falls (Hilverman et al. 2016). This finding serves as a springboard for further investigation into the relationship between gesture and autobiographical memory.

1.2 The development of autobiographical memory

Studies conducted over the past 60 years with conditioning and visual preference paradigms have clearly demonstrated that the ability to store, retain, and recall long-term memories arises rather early after birth (Rovee-Collier & Bhatt, 1993; Rovee-Collier & Shyi, 1992). In an experiment using mobile conjugate reinforcement paradigm, infants as young as three months old were taught that kicking their legs made a mobile hung over their crib shake. After a one-week retention interval, the mobile was reintroduced to infants and most of the babies began kicking their legs, suggesting that they recalled their previous experience with the mobile (Rovee & Rovee, 1969). Also, studies using deferred imitation showed that infants older than 6 months of age are able to retain information for longer periods of time (Campanella & Rovee-Collier, 2005). Infant memory, on the other hand, is highly context dependent at the prelinguistic stage. In subsequent studies conducted in 1990s by Rovee-Collier and her colleagues, it was shown that memory retrieval at earlier ages is highly dependent to the context in which the memory is acquired and retrieval might be entirely disrupted with a single change in contextual features (Borovsky & Rovee-Collier, 1990; Rovee-Collier et al., 1992).

Autobiographical memory is a gradually developing system that emerges by the end of preschool but may not be completely matured until adolescence and early adulthood (Fivush, 2011). Several theories on the development of autobiographical memory have focused on various cognitive precursors and advocate for various onset periods for autobiographical memory. Self-awareness theories centered on either the emergence of mirror self-recognition in the second year of life (Howe & Courage, 1997; Howe et al., 2003) or the emergence of temporal sense of self in the fourth year of life as a requisite to autobiographical memory (Povinelli et al., 1996). According to autonoetic theory, autobiographical memory cannot be achieved until children reach the age of four, when they have acquired the necessary theory of mind skills and have begun to distinguish between "remembering" and "knowing" about an experience (Perner & Ruffman, 1995). Researchers who take a sociocultural approach contend that autobiographical memory does not arise until the preschool years. In particular, parents who speak with their young children about past experiences in an elaborative way, using open-ended questions with episodic details and confirming their children's answers, have children telling more elaborate autobiographical memories (Fivush et al., 2006; Nelson, 1993; Nelson & Fivush, 2004; Reese, 2002; Reese et al., 2010). Children's conversations with adults and significant others act as an important resource for the formation of autobiographical memory in this context, which, of course, demands a certain level of linguistic and narrative competency, which is itself a late developmental achievement.

Relatively recent studies have revealed that an adultlike distribution of autobiographical memories is attained by the age of seven (Bauer et al., 2007), and children's autobiographical narratives improve significantly in length (total number of propositions used to narrate the memory), depth (number of different episodic details given in a memory), and coherence until the age of ten, though they are still not adult-like at that age (Bauer & Larkina, 2019). Thus, in the current study we targeted middle childhood and early adolescence years to explore how gesturing relates to autobiographical memory.

1.3 The role of language in autobiographical memory

Language is one of the core mechanisms playing an important role in autobiographical memory. From the viewpoint of the sociocultural framework, language allows us to communicate our thoughts and feelings on what happened to others, and they can express theirs with us (Fivush & Nelson, 2004, 2006; Hudson, 1990). Thereby, we gain a subjective perspective on the past by learning how others feel and think about the past, and how they are similar to and different from our own feelings and thoughts (Fivush & Nelson, 2004, 2006; Hudson, 1990). The second aspect of the relationship between language and autobiographical memory that has received considerable scholarly attention is whether language development plays a role in the reduction of infantile amnesia, or, to put it another way, whether children can verbally narrate preverbally encoded memories. Simcock and Hayne (2002) showed that children struggle to convert preverbal memories into language until they have acquired the necessary linguistic competence. In a subsequent study, Simcock and Hayne (2003) interviewed 24 to 48-month-old children about a staged event after six months or one year of delay, children's verbal reports mirrored their language abilities at the time of initial encoding rather than at the time of recall, confirming their previous results. Other studies, on the other hand, have shown that children may provide verbal accounts of preverbal events (Morris & Baker-Ward, 2007; Myers et al., 1994). This line of research indicated that proficiency in a language at the time of an event might not be sufficient for later verbal recall of the same event. The delay between encoding and retrieval, as well as the children's age and language skills at the time of the retrieval, may all be predictors of subsequent verbal access to early memories (Cheatham & Bauer, 2005).

Several studies also investigated more direct contributions of language to autobiographical memory. One of the direct contributions of language to autobiographical memory is narrative organization, which defines events in a temporal sequence within an explanatory context for explaining how and why events happened the way they did (Fivush, 2011). When forming an autobiographical memory, narrative offers schemes and guidelines for comprehending how events occur and, as a result, it structures how people recall their own history (Fivush, 2011; Rubin, 2005). Consequently, memories that are structured in a narrative format are easier to recall, more stable, and less susceptible to suggestion (Fivush, 1995). Other linguistic abilities, such as past tense usage and memory verb acquisition (remember and forget), were also found to have a role in the development of meta-cognitive awareness of personal memories (Uehara, 2015; Weist & Zevenbergen, 2008). To put it more clearly, a child's ability to be aware of recalling an event may allow her to organize memories as complete episodes, consolidate them, and retain them for a long time (Uehara, 2015). This is in line with the arguments of Simcock and Hayne (2003), which propose that language skills improve verbal and nonverbal memory for events, allowing children with better language skills to process events at a deeper level.

1.4 Individual differences in gesture use, and the mnemonic function of gestures

Memory, according to the research presented thus far, is more than a mere representation of reality; it is an active reconstruction involving a number of cognitive and linguistic processes that coalesce in adolescence and early adulthood (Bartoli & Smorti, 2019; Conway et al., 2002; Fivush, 2011; Hassabis et al., 2007; McClelland, 2011; Rubin, 2005; Schacter & Addis, 2007). Gestures are characterized as deliberate motor actions performed by the hands, face, or body in place of or in conjunction with an utterance (Wagner et al., 2014). They are an imagistic counterpart to spoken language and they are not bound by linear-linguistic conventions; nonetheless, they work together to convey the intended meaning (Novack & Goldin-Meadow, 2017). By incorporating gestures into their autobiographical memory narration, people may convey episodically and phenomenologically rich memories in a multimodal way.

Gestures are classified into two categories: representational gestures and nonrepresentational gestures. The taxonomy of gestures varies slightly across studies, and the current study adheres to both Cohen and Borsoi (1996) and Feyereisen and

Havard (1999) in categorizing representational gestures which include deictic, iconic and metaphoric gestures. Deictic gestures are two types of pointing movements that are often made with the pointing finger. Concrete pointing gestures are directed to physically present targets such as objects and locations (Feyereisen, 2017; McNeill, 1992). Abstract pointing gestures are directed to empty space to represent absent or abstract elements of the discourse such as past time and the aforementioned arguments (Feyereisen, 2017). As an example, imagine that someone is narrating a memory of her brother's graduation ceremony, and she says, "My mom and dad were also there." To express her parents' locations, she uses a pointing gesture to the left with the word "mom" and a pointing gesture to the right with the word "dad." Iconic gestures portray features of a scene in its form and manner of execution, and the content of an iconic gesture can be identified without any reference to accompanying speech (McNeill, 1992). An iconic gesture could be the one that accompanied the sentence, "there had been a scorpion on the curtain, I hold it without realizing," in which the hand made a grabbing movement. Unlike an iconic gesture, which represents a concrete event or object by creating a congruence to the characteristics of the given event or object, a metaphoric gesture depicts an abstract concept. For example, someone might make a metaphoric gesture in the manner of shaking the hand very slowly with fingers spread apart while saying "I stayed like that for about 5 to 6 minutes." to express her time estimation. Nonrepresentational category includes only beat gestures defined as movements that do not present a discernible semantic meaning but can be easily identified by their movement characteristics, which involve tiny, low energy, quick flicks of the fingers or hand (McNeill, 1992). Though beats do not convey semantic information, they are used to accentuate specific points in a speech (McNeill, 1992).

Speakers differ in the frequency with which they use gestures, the saliency of their gestures, and how much they benefit from using gestures while speaking, encoding, and learning (see Özer & Göksun, 2020 for a review). Variation in gesture use originate from both external and internal sources. The external sources of variation include speech content, communicative context and task difficulty. Regarding speech content, participants produced more gestures when speaking about spatial topics than they did when speaking abstract or neutral topics (for a review see Alibali, 2005; Feyereisen & Havard, 1999; Lavergne & Kimura, 1987). In terms of communicative context, speaker and listener visibility can influence gesture production, with speakers gesturing more when talking face-to-face than when they can not see their listeners (Alibali et al., 2001; Emmorey & Casey, 2001; Krauss et al., 1995). Finally, speakers also produce more gestures when carrying out complex cognitive tasks. As the difficulty of the given task increases it gets harder for speakers to determine what information is suitable for the communicative goal, how to align pertinent information in discourse or how to pack complex information into verbalisable chunks such as the case in describing a complex grid-like diagram (Hostetter et al., 2007; Kita & Davies, 2009).

Internal sources of variation in gesture use are numerous, including age, gender and personality traits (Cohen & Borsoi, 1996; Hostetter & Hopkins, 2002; Hostetter & Potthoff, 2012); however, research primarily focus on two cognitive factors: visual-spatial ability and verbal ability. Gesture studies that take a functionalist approach propose that gestures are generated to deal with and compensate for restricted cognitive resources (Özer & Göksun, 2020). Gestures are believed to reduce cognitive load because gestures actively retain visuo-spatial information in working memory and assist people in projecting their internal representations to external world (Pouw et al., 2014). Thus, it is proposed that limited vocabulary size, verbal working memory, semantic fluency, visuo-spatial working memory, mental rotation ability, and conceptualization ability all lead people to gesticulate more when speaking and thinking (Chu et al., 2014; Gillespie et al., 2014; Hostetter et al., 2007; Özer & Göksun, 2020). For example, in a spatial gesture elicitation task, Göksun et al. (2013) showed that people with weaker spatial abilities as measured by a mental rotation test produced more gestures than individuals with better spatial abilities.

Individual differences in gesture use have been studied mostly in young adults, lacking concrete evidence on how verbal and visuo-spatial abilities relate to gesture use in older children. Developmental studies comparing younger children to older ones or adults, monolingual children to bilingual ones, and typically developing children to atypically developing ones have suggested that children use gestures as a compensation mechanism for their limited linguistic proficiency (Blake et al., 2008; Colletta et al., 2010; Evans et al., 2001; Smithson et al., 2011). Thus, individual differences in children's gesture production appear to be driven by their verbal abilities (see Özer & Göksun, 2020 for a review).

Several accounts have suggested that gesture use may not be solely for compensation. For example, when participants were asked to retell vignettes containing motion events, gestures were observed to accompany the speech to specify the identity of a referent, but gestures were not used for referent identification when the referent was not specified in speech (So et al., 2009). It was concluded that speakers' gestures did not compensate for verbally unspecified referents, but rather that gesture and speech go hand in hand. Moreover, the tradeoff hypothesis suggests that when speaking becomes difficult, gesture takes charge of the communicative load, and vise-versa (De Ruiter et al., 2012).

Previous research revealed that both representational and nonrepresentational gestures are linked to improved recall of impersonal material (e.g., words, speech content) over both short and long retention intervals (Cook et al., 2010). For example, Riseborough (1981) requested adults to watch videos in which a speaker uttered a number of verbs with or without gestures. The results revealed that participants remembered words better when they were coupled with gestures than when they were not. Similarly, Thompson (1995) presented coherent and anomalous 16-word sentences to young adults under three different conditions: speech only, audible and visible speech, and audiovisual speech with representational gestures. When participants were shown representational gestures, they remembered more words from meaningful sentences, suggesting that gestures with a wealth of semantic content that elaborate on the content of the speech may help to strengthen memory for speech (Church et al., 2007). In a language learning study by Kelly et al. (2009), adult participants were given a brief training session in which novel Japanese verbs were presented with and without hand gestures. When gestures provided redundant imagistic information to speech, the greatest vocabulary learning occurred.

All of the research listed above support that viewer of the gesture benefits from gesturing in the recall of impersonal material. More directly related to the questions addressed in the present study, there is some evidence that one's own gesturing has a positive effect on the recall of impersonal material as well. For example, Cook et al. (2008) discovered that after a month, eight- year-old children who were taught mathematics strategies using both speech and gestures recalled more of what they had learned than children who were just taught using either speech or gesture alone. Although children in all conditions received the same lesson and gained roughly the same amount immediately following the lesson, only those who gestured while learning remembered the knowledge they had obtained from the instruction (Cook et al., 2008). Some studies investigated the effectiveness of gestures as a method of elaborated encoding in second language learning. To illustrate, Tellier (2008) showed that five-year-old children retained more words when they encoded and repeated words with gestures than when they encoded and repeated words with pictures.

The majority of studies on the mnemonic function of gestures focus on encoding phase, yet several other studies have found that gesturing during retrieval also improves recall. In a study by Frick-Horbury (2002a), college students were cued either by their own gestures, somebody else's gesture or shown no cues while recalling previously presented concrete and abstract words. Students who were cued by their own gestures were found to have greater recall both immediately and after two weeks of retention interval. Researchers argued that gestures were a component of subjective organization and functioned as distinctive cues facilitating memory retrieval (Frick-Horbury, 2002a, 2002b). Subjective organization also received attention in Endel Tulving's studies conducted in 1960s. During the free recall of unrelated words, subjective organization was manifested as people's tendency to recall items in the same sequence across different trials in the apparent lack of any experimentally manipulated sequential organization and this subjective organization was found to be positively correlated with recall performance (Tulving, 1962).

Self-generated representational gestures might also help to the retrieval of personal material like autobiographical memories. The current study aims at testing how representational gestures produced during memory narration relate to the content and phenomenology of autobiographical memories and whether this potential relation changes as a function of age. Relatedly, the current study will explore whether children and adult use verbal and gestural modalities in isolation or in combination while narrating their memories and how their modality preferences relate to the content of autobiographical memories.

1.5 How could gestures contribute to the autobiographical memory?

1.5.1 Gestures may decrease the cognitive load of verbal reporting

Gesturing may reduce the processing demands of verbal reporting and enable people to allocate most of their cognitive resources to the retrieval of episodically rich autobiographical memories. Earlier gesture theories exclusively focus on how gestures help speaking. First, the Lexical Retrieval Hypothesis asserts that speakers' gestures help them to access the words in their mental lexicon (Morsella & Krauss, 2004). According to this hypothesis, a gesture may cross-modally activate spatial features included in the semantic representation of a lexical item thereby facilitating the retrieval of that specific lexical item (Krauss, Chen, & Chawla, 1996; Krauss, Chen, & Gottesman, 2000; Rauscher et al., 1996). Second, according to the Image Activation Hypothesis (de Ruiter, 2000; Hadar & Butterworth, 1997; Wesp et al., 2001), imagery associated with gestures plays a critical role in lexical search and gestures do not directly involve in the search for words; instead, they retain the spatial non-lexical features in memory while performing the lexical search. Thirdly, according to the Information Packaging Hypothesis, gestures enable speakers to organize rich perceptual-motoric information into packages convenient for speaking (Alibali et al., 2000; Kita, 2000). Spatio-motoric thinking, which underpins gestures, aids speaking by offering an additional informational organization not readily available to analytic thinking, which is the default mode of organizing information while speaking (Kita, 2000). Fourth, the Cognitive Load Reduction Hypothesis states that gesture reduces the amount of cognitive resources required for speech formulation, enabling limited resources to be employed elsewhere (Goldin-Meadow et al., 2001; Wagner et al., 2004). In this last postulation, gesture and speech are considered as complementary modalities of encoding information into an integrated system, one enhancing the other for mutual benefit and, as a result, decreasing cognitive burden (Goldin-Meadow et al., 2001). Some studies exclusively tested the premises of these hypotheses in children, demonstrating that gestures are helpful at all stages of speech production, from conceptual planning of the utterances to the generation of the utterances (Alibali et al., 2000; Pine et al., 2007).

Thus, gesturing might facilitate access to lexical items required during memory reporting (de Ruiter, 2000; Krauss, Chen, & Chawla, 1996; Krauss, Chen, & Gottesman, 2000; Rauscher et al., 1996; Hadar & Butterworth, 1997; Wesp et al., 2001), or it might help people to organize visuo-spatial content of autobiographical memories into a form that can be expressed in words (Alibali et al., 2000; Kita, 2000). Regardless of the exact mechanism, gesturing could decrease the cognitive load of verbal reporting, allowing the allocation of cognitive resources to the retrieval of autobiographical memories containing many episodic details which in turn may increase the phenomenology of the recalled memories.

1.5.2 Gestures may act as externalized nonverbal cues

Gestures can also facilitate learning (e.g., Cook et al., 2008; Goldin-Meadow, 2016; Goldin-Meadow & Wagner, 2005) and problem solving (e.g., Alibali & Kita, 2010;

Alibali et al., 2011; Bucciarelli et al., 2016; Goldin-Meadow & Beilock, 2010; Goldin-Meadow et al., 2009; Hostetter & Boncoddo, 2017; Kirk & Lewis, 2017). For example, to encourage children to use their hands stimulates implicit conceptions which prepare children for learning not only in spatial subjects such as mathematics, but also in non-spatial subjects such as morality (Novack & Goldin-Meadow, 2015). When solving problems with multiple representations, one's propensity to gesture grows in order to externalize some portion of the cognitive process. Thurnham and Pine (2006) analyzed the gestures of five-year-old children while performing true-belief and false-belief tasks that required them to hold either a single or dual representation. In the false belief condition, children were found to be four times more likely to produce gestures than in the true belief condition. In general, gestures seem to provide a steady external physical tool for the cognitive system to externalize some part of the cognitive material that would otherwise be internally retained (Pouw et al., 2014).

What is critical to gestures' capacity to support cognitive processes? In their Gesture as Simulated Action (GSA) framework, Hostetter and Alibali (2008, 2019) suggest that speakers gesture, because while thinking they simulate behavior and perceptual states, and those simulations include motor plans, which form the building blocks of gestures. Alternatively, Novack and Goldin-Meadow (2017) argue that gestures are critical for cognitive processes because they can symbolically represent actions, objects, or ideas. In this latter account, gesture is a unique type of action that symbolizes rather than directly impacts the world. As a result, the fact that gesture is a representational rather than an instrumental action is crucial to its ability to promote generalization and long-term retention (Novack & Goldin-Meadow, 2017).

Gesture for Conceptualization Hypothesis, the most recent and expanded version of the Information Packaging Hypothesis, offers a novel, concise, and comprehensive description of how gestures impact cognition (Kita et al., 2017). Indeed, this framework is a blend of the GSA framework proposed by Hostetter and Alibali (2008, 2019) and the gesture as representational action framework proposed by Novack and Goldin-Meadow (2017). It is assumed that gestures are produced by the same mechanism that produces practical actions; yet, gestures differ from practical actions in that they symbolically represent information. Kita et al. (2017) argues that:

> Representational gestures impact cognitive processes in four ways: they activate, manipulate, package, and explore spatio-motoric representations for speaking and thinking. These four functions are shaped by gesture's ability to schematize information, or its ability to focus on a small fraction of available information (actions and perceptual states) possibly relevant to the task at hand. (pp. 6-7)

In memory retrieval context, gestures may provide additional visual, kinesthetic and bodily cues for the event-to-be-recalled, enabling people to draw upon numerous dimensions of the given event and come closer to re-experiencing the actual temporal/causal unfolding of the original episode (Liwag & Stein, 1995; Madan & Singhal, 2012; Murachver et al., 1996; Risemberg & Zimmerman, 1992). It is known that autobiographical memories involve numerous multimodal constituents and recalling a memory includes simulating these multimodal constituents altogether (Rubin, 2005). As an event unfolds, the brain records signals from various modalities and integrates them into a multimodal representation; later, when the event is remembered, multimodal representations from the original event are reactivated to imitate how the brain portrayed perception, action, and introspection related to the remembered event (Barsalou, 1988, 2008). Going back to the iconic gesture example, if a person is telling her memory of holding a scorpion without realizing and making a gesture of grabbing, then this gesture may remind the specific location of the scorpion sting or the activities she took following the grabbing movement, such as throwing it away.

The enactment effect lends credence to the idea that gestures may act as non-verbal cues in the recall of autobiographical memories. Wesson and Salmon (2001) assigned five- and eight-year-old children to one of three interview conditions; verbal recounting, drawing or re-enacting (through gesture and mime), and then asked children to report a time when they were happy, sad, or fearful. In comparison to verbal recounting, drawing and re-enactment increased the amount of information reported. Stevanoni and Salmon (2005) replicated this finding with six to seven-year-old children who participated in a staged event (visiting the pirate) which had a standardized script and known to the experimenters. Subsequently children were interviewed to test memory of the staged event under four distinct conditions, three of which allowed gesture (gesture-instructed, gesture-modelled, and gesture-allowed), but not the fourth (gesture-not allowed). When prompted to produce gestures during the interview, the children in the gesture-instructed condition provided more detailed and richer event reports than those in the other conditions. When the verbal and gestural information were tallied up, the children in the gesture-instructed condition reported more than twice as much as those in the gesture-not allowed condition (Stevanoni & Salmon, 2005). Not only did gesturing improves verbal reporting of previously experienced events, but it also improves written reports. For example, Risemberg and Zimmerman (1992) looked at how pantomiming a story theme (e.g., topics that are part of everyday life such as flying a kite or playing with snow, as well as topics that tap into the realm of fantasy such as travelling to the moon) can help children write better stories. When children's writing samples were analyzed, it was discovered that children reenacting their stories outperformed the control group in terms of word diversity, narrative length, narrative complexity, and emotional richness (Risemberg & Zimmerman, 1992).

Taking all of this into account, a previously experienced event might be recalled directly using a wide range of cues as long as each individual cue is conceptually tied to the overall memory representation (Barsalou, 1988). Frick-Horbury (2002b) argues that self-generated material like gestures can be viewed easily in terms of distinctive cues because gestures are a separate representation of semantic knowledge and they could activate part of the memory trace. Thus, it is argued that gestures may provide the producer with additional semantic information about a target, including visual, motoric, functional or even episodic knowledge (Frick-Horbury 2002b). In fact, the results of enactment studies back up Frick-Horbury's claims. In each of the aforementioned enactment studies, participants were just gesturing during retrieval, yet nonetheless their gestures could function as cues to activate specific features of the recalled events. Thus, aside from the lightening the load of verbal reporting and leading way to specific memories, gestures can serve as self-generated externalized cues activating the details of the overall event representation, leading way to the recall of episodically rich memories. Furthermore, because "gesture schematizes actions and perceptual states, the action of producing gesture may give additional activation to spatio-motoric aspects of a representation" (Kita et al., 2017, p. 258), one may report a higher proportion of episodic details from several domains such as actions, objects, perceptual states, and descriptions which can be named as visuo-motoric details as opposed to other details such as emotions, cognitive states, or non-episodic details. This possiblity will also be tested in the present study.

1.5.3 Gestures may help scene construction

One another possibility is that gesturing may help individuals to put the information delivered by their utterances in a mental model of the scenes they originally witnessed (Ping & Goldin-Meadow, 2010). While imagining or recalling non-present objects in a visual display, people instinctively make eye saccades to places where the given objects were previously situated (Spivey & Geng, 2001). These eye movements were evaluated as evidence that people construct mental models of visual scenes that they can refer, even when the scene is no longer apparent (Spivey & Geng, 2001). Hostetter and Alibali (2008) argue that gestures originate from the simulations of motor behaviors and perceptual states, if this is true, producing gestures about the non-present elements of the previously witnessed scenes might help people to simulate the visuo-motoric properties of the scenes recalled. Once a scene is created, relevant semantic, contextual, and sensory components can be reactivated and recalled, resulting in the recall of specific and phenomenologically rich memories.

1.6 Gestures and phenomenology of autobiographical memories

In addition to memory content, the phenomenology of autobiographical memories will be examined in relation to gestures. The subjective experience of reliving an event, that is being conscious of a previous conscious experience, is the defining feature of autobiographical memory (Rubin, 2005; Rubin, Schrauf, & Greenberg, 2003). Memories give rise to intense phenomenological experiences, memories can make us laugh or cry, and memories of hard-won victories or embarrassing situations can elicit strong feelings of pride or shame (Sutin & Robins, 2007). Tulving (2002) argues that phenomenology is something that helps people to mentally project themselves backward or forward in time to relive or prelive events. Sutin and Robins (2007) define phenomenology as a cognitive component of memory retrieval. However, research on the cognitive aspects of phenomenology has primarily concentrated on the neurological bases of memory (El Haj et al., 2019) or has exclusively recruited people with severe cognitive deficits such as Alzheimer's disease and dementia (El Haj et al., 2019; Folville et al., 2020). Less research has been conducted on the relationship between basic cognitive processes and phenomenological properties, especially in healthy people.

Mental imagery is one cognitive process that has been studied extensively in relation to phenomenology. Memories that elicit a strong sense of reliving are almost always accompanied by vivid visual images, and people are more likely to believe in memories that include vivid visual images (Greenberg & Knowlton, 2014; Rubin, Schrauf, & Greenberg, 2003). Similarly, people with extremely low visual imagery were shown to have extremely low reliving (Greenberg & Knowlton, 2014). Using a different experimental paradigm in which the visual input was varied at encoding or retrieval of real life events, it was shown that visual input is essential for the recollection and belief of autobiographical memories (Rubin, Burt, & Fifield, 2003).

The relationship between visual imagery and phenomenological experience, according to Rubin et al. (2019), is dependent on scene construction, which involves generating a spatial layout of the remembered event rather than the contents of the scene. Specifically, they revealed that the spatial layout of the remembered event was more significantly associated with reliving, vividness, and belief than the clarity of memory contents separated from their spatial layout (Rubin et al., 2019). A remembered scene is different from an abstract idea or a collection of elements and events that could make up a scene but don't have a specific location in relation to one another or the person recalling them (Rubin, 2019). Thus, an autobiographical memory is considered to lose its most basic context without a spatial layout and is thus seen as knowledge, with reduced reliving and vividness, as well as reduced belief that the event actually happened (Rubin et al., 2019; Rubin & Umanath, 2015). The association between scene construction and phenomenological experience was also supported by neuroimaging studies. In a study by Daselaar et al. (2008), adult participants recalled personal memories in response to cue words during an fMRI scan, to map the brain regions that underlie phenomenological experiences of reliving as well as emotional intensity. Reliving ratings were found to be correlated with the activity in visual cortex and ventromedial and inferior prefrontal regions which were involved in elaborating a scene (Daselaar et al., 2008).

As a part of a general multimodal event representation, gestures produced during memory narration might increase the phenomenological experience of visual imagery, spatial imagery, and reliving. More specifically, gesturing during memory narration might help people to construct mental models of the previously witnessed scenes (Ping & Goldin-Meadow, 2010; Spivey & Geng, 2001), allowing people to recall more details (e.g., shapes, locations of objects and people) which could in return contribute to the phenomenological experience of visual imagery, spatial imagery and reliving.

1.7 The use of verbal and gestural modalities in the narration of autobiographical memories

A key question is whether gestural and verbal modalities are unified from the beginning, or whether they are originally separate and only become unified system with development (McNeill, 1992). Although several views have been proposed on this issue (e.g., Butcher & Goldin-Meadow, 2000; Iverson & Thelen, 1999), what is developmentally important is that the close coupling between gestural and verbal modalities change as children go through developmental stages (Capirci & Volterra, 2008). At earlier stages of communicative development, around 11 to 13 months of age, children's gesture repertoire seems to be larger than their vocal repertoire; later, around 13 to 15 months of age, children go into a bimodal period where both modalities are used to communicate; and subsequently, around 21 to 24 months of age, a clear switch from gesture to verbal modality is observed (Capirci & Volterra, 2008; Iverson et al., 1994; Volterra et al., 2005). However, this shift to vocal modality does not rule out the use of gestures in children's communication (Capirci & Volterra, 2008; Iverson et al., 1994). Yet, research on older children's gesture production suggests that when reasoning about balance or mathematical equivalence, or when engaging in problem solving tasks, children express a substantial portion of their knowledge in a multimodal way through verbal+gestural utterances (Alibali & Goldin-Meadow, 1993; Church & Goldin-Meadow, 1986; Pine et al., 2004).

The second point to consider is that gesture use is specifically related to language growth at later stages of communicative development (Capirci & Volterra, 2008). The frequency and complexity of gestures produced by older children and adults are strongly linked to the frequency and complexity of their spontaneous language (Colletta et al., 2010; Mayberry & Nicoladis, 2000; Nicoladis et al., 2016). The studies investigating multimodal narratives of children aged 6 to 12 years and adults from different languages including English (Colletta et al., 2015), French (Colletta et al., 2010), Italian (Graziano, 2009) and Zulu (Nicolas et al., 2017) revealed that gesture use is coupled with the development of narrative skills. Children's narratives become longer and more detailed as they get older, with numerous subordinate clauses and connector words, and gestures contribute as structural and pragmatic markers to this information complexity (Colletta et al., 2015). Furthermore, at later stages of communicative development, the gestural repertoire is restructured, and new gesture types such as beats, metaphoric gestures, and gestures of discourse cohesion (e.g., gestures that go with connector words, abstact pointings addressed to the empty space to refer to individuals or objects) appear (Colletta, 2009; McNeill, 1992). Thus, it becomes easier to convey complex narratives with the addition of these new types of gestures into the communication repertoire. Because gestures assist narrators in representing narrated elements, tracking reference, indicating perspective change, marking the discourse progression, and, most importantly, building narrative cohesion, which is essentially linking episodes temporally, thematically, and causally. (Colletta, 2009; Colletta et al., 2010, 2015; McNeill et al., 2015; Nicoladis et al., 2016).

Autobiographical memories have a narrative quality, in the sense that we organise our experiences of events in the same way that we organise a story (Radvansky et al., 2005), and narrative is a complex form of discourse containing three layers of complexity: plot complexity, evaluative complexity and syntactic complexity (Ögel-Balaban & Hohenberger, 2020). Plot complexity is characterized as the capacity to convey a sequence of events in a hierarchical structure that emphasizes the onset, unfolding, and resolution of the event. From a developmental standpoint, Turkish speaking 7-to 8-year-olds were found to be similar to 10- to 11-year-olds, but neither group reached adult levels of plot complexity (Ögel-Balaban & Hohenberger, 2020). The narrators occasionally depart from the plot of the story and introduce their own point of view or interpretations, such as recounting the events' causes or outcomes, as well as the behaviors of the story's characters (Ögel-Balaban

& Hohenberger, 2020). Although children as young as four years old could incorporate their own interpretations into their narrative to some degree, the development of evaluative complexity occurs only during adolescence and adulthood (Ögel-Balaban & Hohenberger, 2020). Syntactic complexity is a key characteristic of human language that is achieved by the recursive, hierarchic arrangement of linguistic components under the guidance of syntactic rules (Ögel-Balaban & Hohenberger, 2020). From the age of 11 to adulthood, there are developmental changes in the usage of syntactically complicated clauses in narratives (Ögel-Balaban & Aksu-Koç, 2020; Ögel-Balaban & Hohenberger, 2020). Other studies conducted with Turkish speaking children has also revealed that narrative performance is a joint function of the narrator's cognitive and linguistic abilities, and that this capacity develops with age, with substantial improvement in adolescence and adulthood (Aksu-Koç, 1994; Aksu-Koç & Stutterheim, 1994).

In the context of autobiographical memories, with increasing age, it is possible that people may narrate their memories of past events in a more complex way and their tendency to incorporate gestural modality into this narration may vary. The present study will examine whether children and adult use verbal and gestural modalities in isolation or in combination while narrating their memories.

1.8 The present study

Originating from the variations in visual-spatial and verbal cognitive capacities, people of all ages vary in terms of how much they use gestures, how saliently they produce gestures, and what kinds of gestures they use during speaking (e.g., Arslan & Göksun, 2021; Chu et al., 2014; Feyereisen & Havard, 1999; see Özer & Göksun, 2020). People also vary in how much they gain from gesturing during speaking, learning and recall (e.g., Goldin-Meadow et al., 2001). It is likely that people also show variation in gesture use during autobiographical memory narration, which could have repercussions for autobiographical memory. This study investigates, how gesturing during memory narration relates to the content and phenomenology of autobiographical memories, as well as, whether gestural and verbal modalities are used together or separately when narrating autobiographical memories.

The first question addressed in this study is how representational gestures produced during autobiographical memory narration relate to content and phenomenology of autobiographical memories, and whether this potential relation holds similarly in children and adults. It is hypothesized that there will be a positive association between the frequency of representational gestures produced during memory narration and the total number of episodic details recalled. The same positive association is also expected between the frequency of representational gestures and visuo-motoric details describing actions, objects, perceptual states and descriptions. On the contrary, no association is expected between the number of representational gestures and non-episodic details which are not directly related to the specific event being recalled.

The brain network that supports autobiographical memory retrieval develops slowly and continues well into adolescence, implying that the neurological processes involved in autobiographical memory retrieval are different in children and adults (Bauer, 2015). Adults exhibit higher levels of activity in the hippocampus (including the parahippocampal area), as well as the prefrontal and parietal regions involved in episodic memory retrieval (Bauer et al., 2017). Additionally, these activation differences are more noticeable in the early phases of retrieval, when memory search and access processes predominated (Bauer et al., 2017). In comparison to children, adults might use gestures more efficiently as externalized tools during search and access processes and later report more details. Moreover, adult memories have greater length, depth and coherence (Bauer & Larkina, 2019) and it is known that narrative complexity is one of the predictors of gesture production in a narrative context (Nicoladis et al., 2016). Thus, the hypothesized association between representational gestures and episodic details as well as visuo-motoric details is expected to be stronger in the adult group.

Based on the work showing that mental imagery (Greenberg & Knowlton, 2014; Rubin, Burt, & Fifield, 2003; Rubin, Schrauf, & Greenberg, 2003) and scene construction (Daselaar et al., 2008; Rubin, 2019; Rubin et al., 2019; Rubin & Umanath, 2015) are key cognitive processes in the phenomenology of autobiographical memories, it is expected that gestures produced during memory narration will increase the phenomenological experience of visual imagery, spatial imagery, and reliving. More specifically, gesturing during memory narration might help people to construct mental models of the previously witnessed scenes (Ping & Goldin-Meadow, 2010; Spivey & Geng, 2001), allowing people to recall more details (e.g., shapes, locations of objects and people) which could in return increase the phenomenological experience of visual imagery, spatial imagery and reliving.

Phenomenology has received scant attention in developmental studies of autobiographical memory. Bauer et al. (2016) conducted the first and only study that compared the phenomenological properties of adult and child autobiographical memories. Adolescents and young adults have more similarities than differences in emotionality, arousal, significance, vividness, completeness, confidence, perspective and frequency of retelling (Bauer et al., 2016). Based on this single study, it can be predicted that gesture production will be positively associated with phenomenological ratings by increasing the total number of details remembered similarly in children and adults. However, due to the scarcity of phenomenological studies involving children, as well as developmental differences in autobiographical memory and gesture use, it is difficult to hypothesize about the moderating role of age on the direct and indirect links between gesture and phenomenological ratings. Thereby, how age would moderate the relation between gesture and phenomenology will be examined in an exploratory way.

Lastly, the present study will examine whether children and adults use verbal and gestural modalities in isolation or in combination while narrating their memories. Similar to what was found in the studies comparing multimodal narratives of older children and adults (Colletta et al., 2010, 2015; Graziano, 2009; Nicolas et al., 2017), it is possible that as autobiographical memories get longer and more detailed, both adults and children may use verbal and gestural channels in combination. The complexity of the information in the memory representation may lead participants to use more subordinate clauses and connector words, which also may necessitate the use of gestures to reduce the cognitive load of verbal reporting. Alternatively, scenes containing visuo-motoric information may trigger representational gestures as a result of stimulation or as a requirement to package visuo-motoric information into utterances. These possibilities for gesture use may also apply to children, as children use verbal+gestural utterances in a variety of tasks (e.g., Alibali & Goldin-Meadow, 1993; Church & Goldin-Meadow, 1986; Pine et al., 2004). As a consequence, both children and adults are expected to express many of the details they remember using both verbal and gestural modalities; however, this propensity to use both modalities is expected to be greater in adults as their memories will be longer (see Bauer & Larkina, 2019).

Other than age group, the episodic nature of the recalled details is expected to lead participants to use verbal and gestural modalities together. In comparison to non-episodic details, episodic details may be more interwoven with the representations that underpin representational gestures. The fact that mental imagery and scene construction processes are the basis of autobiographical memory specificity and gesture use strengthens this possibility (Greenberg & Knowlton, 2014; Hassabis et al., 2007; Hassabis & Maguire, 2007; Mullally et al., 2012; Schacter & Addis, 2007; Sheldon & Levine, 2016; Ping & Goldin-Meadow, 2010; Wheeler et al., 2000). In particular, when reporting non-episodic details like repeated events, extended states of being, general facts, or metacognitive statements, the likelihood of producing representational gestures may be low. For example, in the concluding statement of a memory report that includes a metacognitive statement like "This incident was a turning point for our brotherhood relationship; we never quarreled again," the visuo-motoric information, the building blocks of gestures, may be sparse. Similarly, because this metacognitive information is derived from many different incidents (e.g., events in which brothers helped one another, events in which brothers achieved to stay calm) the likelihood of constructing a specific scene may be minimal. Thus, both children and adults are expected to convey episodic details mostly by the use of verbal and gestural modalities, rather than non-episodic details that are not directly related to the event.

CHAPTER 2

METHOD

2.1 Participants

There was a total of 93 participants (42 children, 51 adults). Adult participants were recruited from undergraduate classes of two public universities in exchange for course credit and children were recruited from a secondary school in exchange for a book donated to the school library on their behalf. The research was approved by Institutional Review Board at Bogazici University (see Appendix A for Ethics Committee Approval).

Six children and one adult were excluded from the sample due to audiovisual recording errors. Three additional adults were also excluded; two of them were suspected of having depression history since they could not recall any specific memories, and one participant who grew up in Germany was excluded as she was not fluent enough in Turkish. One participant from the adult sample and one from the child sample, recalled fewer than three memories out of six cue words and were thus excluded from further analysis. Therefore, the final sample consisted of 81 participants: 35 children aged 9 to 14 (M = 11.46, SD = 1.37, 21 females), and 46 young adults aged 19 to 23 (M = 19.96, SD = 1.07, 27 females).

2.2 Procedure

In the case of child participants, parental consent was obtained in addition to children's verbal assent, and young adults provided informed consent prior to participation. In a single session lasting about 30 to 60 minutes, each participant was tested individually in a quiet room located in the corresponding institution. Child and adult participants were asked to recall six autobiographical memories in response to cue-words. After narrating their memories, participants also provided phenomenological ratings on visual imagery, spatial imagery and reliving. Testing was carried out by the same experimenter, and the testing session was videotaped for subsequent coding.

2.3 Measures

2.3.1 Autobiographical Memory Test (AMT)

The TEMPAu task (Test Episodique de Memoire du Passe Autobiographique: Piolino et al., 2007; Willoughby et al., 2012), child adapted version of AMT (Williams & Broadbent, 1986) was used to assess children's autobiographical memory. It is a semi-structured autobiographical questionnaire and for the purposes of the current study, children were prompted by six cue words (forest, house, book, shoe, success, danger) to recall one memory for each word. Participants were instructed that memories should be one-time events that occurred in a specific context and over a short period of time. Substitutes (sea, car, newspaper, pillow, help, mistake) were also provided to participants when they failed to recall a memory. All selected cue words and their substitutes have medium (50-90) to high (≥ 100 per million) frequency ratings (Tekcan & Göz, 2005). In order to ensure that each cue-word has a comparable potential to cue memories both in adults and children, age of acquisition norms were taken into consideration and all the cue-words and substitutes were chosen among the ones having age of acquisition estimates before age 5 (Göz et al., 2017). Cue-words were presented to participants in a counterbalanced way such that, across participants, each cue word appeared equally often in each presentation order. Generic prompts such as “Could you tell me about one time you ______?” were provided when necessary. The procedure was implemented in the same manner to adult participants.

2.3.2 Phenomenological ratings

After narrating each memory, participants were asked to rate their memories on the following phenomenological properties; visual imagery, spatial imagery, and reliving by using a five-point scale as usually applied by studies using Autobiographical Memory Questionnaire (AMQ: Rubin, Schrauf, & Greenberg, 2003) or Memory Characteristics Questionnaire (MCQ: Johnson et al., 1988). Statements used to measure each of the phenomenological properties were presented in Table 1.

Table 1. Phenomenological Properties Rated by the Participants

Phenomenological Properties	Statement
Visual Imagery	As I remember this event, I can see the details or the colors of the things related to the event.
Spatial Imagery	As I remember this event, I can remember spatial details of the place (such as the location of objects) where the event took place.
Reliving	As I remember the event, I feel as though I am reliving it.

Note: Adapted from “Belief and recollection of autobiographical memories,” by D. C. Rubin, R. W. Schrauf, and D. L. Greenberg, 2003, *Memory & Cognition, 31*(6), p. 889.

2.4 Coding

Episodic and non-episodic details in autobiographical memories, gestures produced during memory narration and the modality in which each memory detail was reported, were all coded. Video recordings were transcribed before coding and data coding was conducted in the ELAN annotation tool (Brugman & Russel, 2004). Two reliability coders blind to the hypotheses were trained by the author (principal coder) and coded 20% of the data. The overlap between principal coder and each reliability coder was 10%. For each coded variable, interclass correlation coefficients (ICC) were computed, based on a single rater, absolute-agreement, two-way mixed-effects model.

2.4.1 Memory content

Memory content was coded according to the schemes previously used by Levine et al. (2002), Addis et al. (2008) and Aydın (2018). For each recalled memory, the central event was identified, if there were more than one event then the most detailed one which occured in a relatively brief time was chosen for the coding. Selected central events were segmented into two broad detail categories: episodic details and non-episodic details. Non-episodic details are the ones which are not directly related to the central event and they contain semantic information, extended events, metacognitive statements, repetitions and specific details of other noncentral events (Levine et al., 2002). Specific examples for each category of non-episodic detail are provided in Appendix B. Episodic details are directly linked to the central event and they are consisted of ten categories: (1) who (specific people participating in the event), (2) what-object (specific objects existing in the event), (3) what-action (activities that a person or an object engaged in), (4) where (location of the event or a preposition indicating place), (5) when (placement of the event in time), (6) why (indication of causation), (7) how-description (adjectives or adverbs that describe an action, an object, or a situation), (8) how-evaluation (indication of internal states), (9) perceptions (details pertaining to visual, tactile, auditory, olfactory and taste information) and (10) events (collective events with a specific event scheme). For each category of episodic detail, specific examples are listed in Appendix C. Details for each category were tallied and summed to create episodic and non-episodic scores, which were the primary variables of interest in this study. The ICCs for episodic details were 0.75 (p = .012) and 1 for the first and second coders, respectively. The obtained ICC values for non-episodic details were excellent both with the first coder and the second coder, being .91 (p < .001) and 1 respectively.

Four subtypes of episodic details were tallied, including what-object, what-action, how-description, and perceptions, to create the visuo-motoric details subcategory, which is another main variable of memory content. According to Kita et al. (2017), representational gestures are thought to activate, manipulate, package, and explore spatio-motoric representations; thus, representational gestures produced during memory narration may activate visuo-motoric details such as actions, objects, descriptions, and perceptual states. The ICCs for categorizing visuo-motoric details were 0.65 (p = .013) and 1 for the first and second coders, respectively.

2.4.2 Gesture

Any hand movement that was a part of a speaking event, had a clear beginning-end, and was executed in the visual field of the listener was qualified as a gesture (Iverson, 1999; Iverson & Goldin-Meadow, 1997). Gestures were classified into four categories as deictic, iconic, metaphoric, and beats (McNeill, 1992). Deictic, iconic and metaphoric gestures were categorized as representational while beat gestures as nonrepresentational. Participants in the current study commonly employed deictic gestures to indicate the locations of individuals or objects when reporting their memories, hence deictics were classified as representational gestures. To quantify the frequency of representational gestures for each memory recalled, the total number of deictic, iconic, and metaphoric gestures were added and then divided by the total number of words uttered to report the given memory, which was then multiplied by

100 to yield the representational gesture count per 100 words. Thereby, the effect of speaking length was controlled because as participants talk more, the number of gestures they produce increase (So et al., 2009). For gesture frequency, ICC values turned out to be 0.86 (p = .001) with the first coder and 0.97 (p < .001) with the second coder.

2.4.3 Modality

To explore the modality though which each episodic and non-episodic detail was reported, we identified which details were uttered via (1) only-verbal utterances in which the main word or phrase specifying the given memory detail was uttered using speech without producing gesture, (2) only-gestural utterances in which the given memory detail was conveyed by gesturing without talking, and finally (3) verbal+gestural utterances in which the main word or phrase specifying the given memory detail was uttered using both speech and gesture. Only-gestural utterances were extremely rare in the data, only one child produced one only-gestural utterance. Thus, only-gestural category was merged with the category of verbal+gestural utterances. The ICCs for categorizing details reported via verbal+gestural utterances were 0.90 (p < .001) and 0.99 (p < .001) for the first and second coders, respectively. The ICCs for categorizing details reported via only-verbal utterances were 0.88 (p = .001) and 0.95 (p < .001) for the first and second coders, respectively.

2.5 Statistical analyses

There were six cue words for which memories were elicited and ratings were provided. For each variable (e.g., episodic details, non-episodic details visual imagery ratings), we computed the mean score across the memories participants reported. Interrater reliability analyses, descriptive/preliminary analyses and main analyses were all conducted using SPSS 25.0 for Windows. The moderation analyses (Model 1) and the moderated mediation analyses (Model 15) were tested using the PROCESS macro (Hayes, 2013) and hypotheses were tested with bootstrapping (*n* = 5000). Sensitivity power analyses were conducted with G*Power (Faul et al., 2007).

CHAPTER 3

RESULTS

3.1 Preliminary analyses

Possible group differences between children and adults in terms of gesture use (representational and nonrepresentational gesture production), memory content (episodic details, visuo-motoric details and non-episodic details), and phenomenological ratings (visual imagery, spatial imagery and reliving) were analyzed. The descriptive statistics are presented in Table 2.

Table 2. Descriptive Statistics for Study Variables

Study Variables	Age Group	N	Mean	Median	SD	Min	Max
Representational Gesture*	Adult	46	8.87	9.04	4.48	0.36	17.18
	Child	35	3.08	2.13	2.99	0	12.52
Nonrepresentational Gesture*	Adult	46	9.85	9.31	4.77	0.37	24.70
	Child	35	5.42	4.00	4.95	0	19.47
Episodic Detail*	Adult	46	12.57	10.91	5.26	5.25	31.33
	Child	35	9.31	7.60	4.32	4.83	26.67
Visuo-Motoric Detail	Adult	46	6.48	5.66	3.22	1.50	17.67
	Child	35	5.12	4.40	2.95	2.20	17.67
Non-episodic Detail*	Adult	46	3.36	3.00	2.27	0.67	11.33
	Child	35	1.79	1.16	1.69	0.40	7.17
Visual Imagery	Adult	46	4.00	4.08	0.57	2.67	5.00
	Child	35	3.93	4.16	0.63	2.50	5.00
Spatial Imagery	Adult	46	4.15	4.16	0.56	2.67	5.00
	Child	35	4.06	4.00	0.59	2.60	5.00
Reliving	Adult	46	3.99	4.00	0.72	2.00	5.00
	Child	35	3.87	4.00	0.84	2.00	5.00

*The mean difference is significant at the 0.05 level (2-tailed).

3.1.1. Gesture use

Independent samples t-tests were conducted to examine whether children and adults differed in gesture use. Adults produced more representational (M = 8.87, SD = 4.48) gestures than children (M = 3.08, SD = 2.99), $t(79)$ = 6.59, 95% CI [4.04, 7.53], $p <$ .001. Similarly, adults used nonrepresentational gestures (M = 9.85, SD = 4.77) more frequently than children (*M* = 5.42, *SD* = 4.95), *t*(79) = 4.06, 95% CI [2.25, 6.59], *p* < .001.

3.1.2. Memory content

To see how children and adults differ in the type of details they reported in their memories, a 2x3 mixed design ANOVA using age (child vs. adult), and detail type (episodic detail, visuo-motoric detail and non-episodic detail) was performed. Memory content had a significant main effect, *F*(2, 158) = 302.60, *MSE* = 4.67, *p* < .01. Number of episodic details reported in memories (*M* = 10.94, *SE* = 0.54) outnumbered both visuo-motoric details (*M* = 5.80, *SE* = .34), *p* < .01, 95% CI [4.58, 5.69] and non-episodic details (*M* = 7.47, *SE* = .45), *p* < .01, 95% CI [7.25, 9.47]. Overall, adults' memories (*M* = 7.47, *SE* = .45) contained more details than those of children (*M* = 2.57, *SE* = .22), *F*(1, 79) = 8.96, *MSE* = 28.29, *p* = .004, 95% CI [0.69, 3.43]. There was also an interaction between memory content and age, *F*(2, 158) = 4.55, *p* = .012. Post hoc tests using the Bonferroni correction revealed that adults reported more episodic (*p* = .004, 95% CI [1.07, 5.43]) and non-episodic details (*p* = .001, 95% CI [0.65, 2.48]) than children; however, they did not differ in the number of visuo-motoric details they reported (*p* = .053, 95% CI [-0.21, 2.75]).

3.1.3. Phenomenological ratings

To assess potential age group differences in phenomenological ratings of visual imagery, spatial imagery and reliving, independent samples t-tests were conducted. On visual imagery, children (*M* = 4.00, *SD* = 0.57) were found to be similar to adults (*M* = 3.93, *SD* = 0.63), *t*(79) = 0.55, 95% CI [-0.19, 0.34], *p* = 0.58. Moreover, adults (*M* = 4.15, *SD* = 0.56) and children (*M* = 4.06, *SD* = 0.59) did not differ in spatial imagery $t(79) = 0.75$, 95% CI [-0.16, 0.35], $p = 0.45$. Lastly, reliving ratings did not differ between adults ($M = 3.99$, $SD = 0.72$) and children ($M = 3.87$, $SD = 0.84$), $t(79) = 0.68$, 95% CI [-0.22, 0.46], $p = 0.49$.

3.1.4. Bivariate relations

Pearson correlations were run to test the bivariate relations among study variables separately in adult and child groups. Results are presented in Table 3. As there was a broad age range in the child group, we examined its association with the study variables. It was revealed that only reliving ratings ($r = -.379$, $p = .025$) are associated with age in the child group.

3.2 Representational gestures and autobiographical memory content

Three moderation analyses were conducted to examine the age dependent relation between representational gesture production and one of three components of memory content: episodic details, visuo-motoric details, and non-episodic details[1]. The amount of representational gestures produced during memory narration was hypothesized to have a positive relationship with the total amount of episodic details recalled. The same positive association was expected between the amount of representational gestures and visuo-motoric details defining actions, objects, perceptual states, and descriptions in the recalled event. No association was expected between the amount of representational gestures and non-episodic details. The hypothesized associations between representational gestures and episodic details as

[1] Current moderation analyses with 81 participants would be sensitive to effects of Cohen's $f^2 = 0.16$ with 90% power (alpha = .05). For episodic details the observed effect size is $f^2 = 0.51$, for visuo-motoric details the observed effect size is $f^2 = 0.38$ and for non-episodic details observed effect size is $f^2 = 0.20$. Thus, current moderation analyses have decent power to detect reported moderation effects (see Appendix D for the sensitivity plot).

well as visuo-motoric details were expected to be stronger in the adult group. Results of the three moderation analyses are presented in Table 4.

3.2.1 Episodic details

Current moderation analysis tested whether there was an age dependent relation between representational gestures and the number of episodic details remembered about the recalled event[2]. In predicting the total number of episodic details about the recalled events, the total number of representational gestures produced during memory narration and age explained a significant amount of variance, $F(3, 77) = 13.33$, $p < .001$, $R^2 = .34$. The relationship between representational gestures and episodic details was moderated by age, $b = -0.72$, 95% CI [-1.28, -0.17], $t = -2.60$, $p = .010$. In the adult group, the increase in the total number of representational gestures was associated with the recall of more episodic details, $b = 0.74$, 95% CI [0.46, 1.02], $t = 5.31$, $p < .001$. However, in the child group, the total number of episodic details did not increase as children's representational gesture frequency increased, $b = 0.01$, 95% CI [-0.46, 0.49], $t = 0.071$, $p = .943$. The moderating effect of age is presented in Figure 1.

[2] To investigate how much variance in the number of episodic details was accounted for by the wide range of children's ages in the presence and absence of representational gestures, a two-stage hierarchical multiple regression using the enter method was conducted. Results revealed that at stage one, age accounted for only 1% of the variance in the number of episodic details reported, $F(1, 33) = 0.33$, $p = .569$. Adding representational gestures into the regression model at stage 2 accounted for 1.2% ($\Delta R^2 = 0.002$) of variation in the number of episodic details, and this change in R^2 did not contribute significantly to the regression model, $F(2, 32) = 0.19$, $p = .822$.

Table 3. Bivariate Relations among Study Variables

Age Groups	Study Variables	1	2	3	4	5	6	7	8
Adult	1. Age	-	-.092	-.157	-.174	.127	.160	.170	-.026
	2. Representational Gesture		-	.415**	.391**	.274	.081	-.190	-.067
	3. Episodic Detail			-	.969**	.512**	.179	.032	.000
	4. Visuo-Motoric Detail				-	.407**	.223	.047	-.005
	5. Non-episodic Detail					-	.145	.056	.070
	6. Visual Imagery						-	.768**	.507**
	7. Spatial Imagery							-	.538**
	8. Reliving								-
		1	2	3	4	5	6	7	8
Child	1. Age	-	.332	-.100	-.167	-.125	-.271	-.148	-.379*
	2. Representational Gesture		-	-.004	.003	-.145	-.305	-.159	-.044
	3. Episodic Detail			-	.968**	.726**	-.085	-.054	.141
	4. Visuo-Motoric Detail				-	.681**	-.085	-.020	.200
	5. Non-episodic Detail					-	.121	.194	.093
	6. Visual Imagery						-	.566**	.504**
	7. Spatial Imagery							-	.545**
	8. Reliving								-

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

Table 4. Age as a Moderator in the Relation between Representational Gesture and Memory Content

Predictors	On Episodic Details				On Visuo-Motoric Details				On Non-episodic Details			
	B	SE	*p*	95% CI	*B*	SE	*p*	95% CI	*B*	SE	*p*	95% CI
Age Group	3.32	1.73	0.059	[-0.13, 6.77]	2.56	1.11	0.024	[0.34, 4.79]	-0.17	0.82	0.835	[-1.81, 1.47]
Representational Gesture	1.47	0.37	0.0002	[0.73, 2.21]	0.87	0.23	0.0005	[0.39, 1.34]	0.32	0.17	0.067	[-0.02, 0.67]
Representational Gesture x Age Group	-0.72	0.27	0.010	[-1.28, -0.17]	-0.40	0.18	0.025	[-0.76, -0.05]	-0.18	0.13	0.172	[-0.44, 0.08]
R^2	0.34				0.28				0.17			
F	13.33				10.39				5.60			

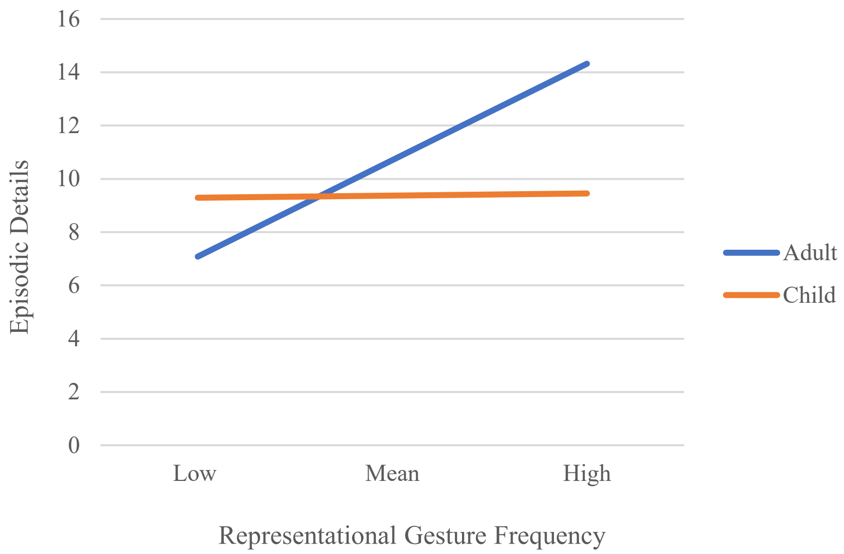

Figure 1. Moderating effect of age in the relation between representational gestures and episodic details

3.2.2 Visuo-motoric details

Another moderation analysis was performed to determine whether representational gestures produced during memory narration activated visuo-motoric details such as actions, objects, descriptions, and perceptual states differently in children and adults[3]. Total number of representational gestures and age explained 28% of the variance in visuo-motoric details one reported in an event, $F(3, 77) = 10.39$, $p < .001$. The relationship between representational gestures and visuo-motoric details was moderated by age, $b = -0.40$, 95% CI [-0.76, -0.05], $t = -2.27$, $p = .025$. In the adult group, the increase in the total number of representational gestures was associated with the recall of more visuo-motoric details, $b = 0.46$, 95% CI [0.28, 0.64], $t = 5.10$, $p < .001$. However, in the child group, the total number of visuo-motoric details did

[3] To investigate how much variance in the number of visuo-motoric details was accounted for by the wide range of children's ages in the presence and absence of representational gestures, a two-stage hierarchical multiple regression using the enter method was conducted. Results revealed that at stage one, age accounted for only 2.8% of the variance in the number of visuo-motoric details reported, $F(1, 33) = 0.94$, $p = .338$. Adding representational gestures into the regression model at stage 2 accounted for 4.1% ($\Delta R^2 = 0.013$) of variation in the number of visuo-motoric details, and this change in R^2 did not contribute significantly to the regression model, $F(2, 32) = 0.68$, $p = .511$.

not increase as children's gesturing frequency increased, $b = 0.05$, 95% CI [-0.25, 0.36], $t = 0.33$, $p = .735$. The moderating effect of age is presented in Figure 2.

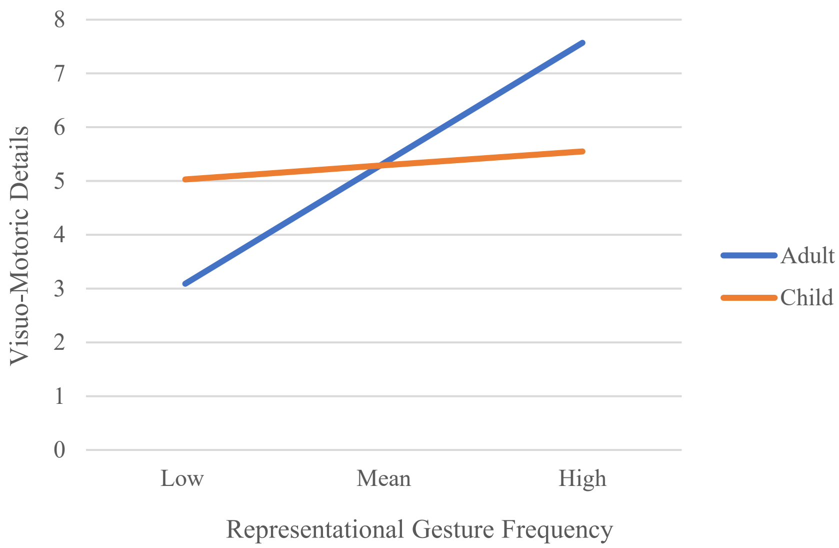

Figure 2. Moderating effect of age in the relation between representational gestures and visuo-motoric details

3.2.3 Non-episodic details

Similar to earlier results, total number of representational gestures produced during memory narration and age explained a significant amount of variability in the number of non-episodic details one reported, $F(3, 77) = 5.60$, $p = .0016$, $R^2 = .17$[4]. However, neither representational gesture production ($b = 0.32$, 95% CI [-0.02, 0.67], $t = 1.85$, $p = .067$) nor age ($b = -0.17$, 95% CI [-1.81, 1.47], $t = -0.20$, $p = .835$) appeared as an important predictor for the number of non-episodic details reported. Also, age did not function as a moderator in the relation between representational

[4] To investigate how much variance in the number of non-episodic details was accounted for by the wide range of child age in the presence and absence of representational gestures, a two-stage hierarchical multiple regression using the enter method was conducted. Results revealed that at stage one, age accounted for only 1.6% of the variance in the number of non-episodic details reported, $F(1, 33) = 0.52$, $p = .475$. Adding representational gestures into the regression model at stage 2 did not account for any additional variance ($\Delta R^2 = 0.001$) in the number of non-episodic details, and the second regression model was also insignificant, $F(2, 32) = 0.26$, $p = .767$.

gesture and the number of non-episodic details reported, b = -0.18, 95% CI [-0.44, 0.08], t = -1.37, p = .172. Interaction results are presented in Figure 3.

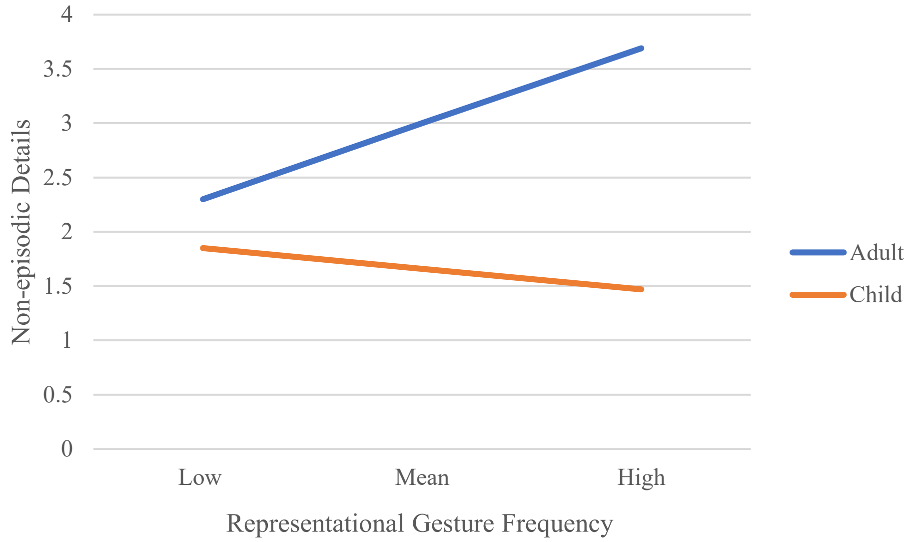

Figure 3. Moderating effect of age in the relation between representational gestures and non-episodic details

3.3 Representational gestures and phenomenology

It was expected that gestures produced during memory narration would help people in recalling more details, thereby increasing the phenomenological experience of visual imagery, spatial imagery, and reliving. No age-dependent direction was hypothesized for any of the relationships between representational gesture and one of three phenomenological ratings. Three moderated mediation analyses were performed to understand whether representational gestures relate to each of the phenomenological ratings by increasing the total number of details remembered, and whether this mediation effect differs statistically between children and adults[5].

[5] Current moderated mediation analyses (n= 81) had 90% power to detect an effect size of at least f^2 = 0.18. For visual imagery the observed effect size is f^2 = 0.04, for spatial imagery the observed effect size is f^2 = 0.01 and for reliving ratings observed effect size is f^2 = 0.01. Thus, current moderated mediation analyses does not have adequate power to detect these indirect effect sizes which are quite small (see Appendix E for the sensitivity plot).

3.3.1 Visual imagery

The current analysis tests whether representational gestures relate to visual imagery ratings by increasing the total number of details remembered and whether this mediation effect holds for both children and adults (see Table 5). In line with the predictions, as participants produced more representational gestures during memory narration, they reported more details about the recalled events, $b = 0.72$, 95% CI [0.45, 0.98], $t = 5.45$, $p < .001$. However, results revealed that representational gestures ($b = 0.08$, 95% CI [-0.04, 0.20], $t = 1.33$, $p = .186$) and total number of details remembered ($b = 0.01$, 95% CI [-0.06, 0.09], $t = 0.37$, $p = .707$) were not significant predictors of visual imagery ratings. Age did not have a moderating effect on the relation between gesture ($b = -0.05$, 95% CI [-0.14, 0.03], $t = -1.28$, $p = .201$) or total number of details ($b = -0.008$, 95% CI [-0.05, 0.04], $t = -0.33$, $p = .735$) and visual imagery ratings. Moreover, the results revealed a non-significant moderated mediation effect, $b = -0.006$, SE = .0168, 95% CI [-0.04, 0.02].

3.3.2 Spatial imagery

A second moderated mediation model was run to see whether participants' phenomenological experience of spatial relations in their memories was related to the production of representational gestures via the increase in the total number of details remembered (see Table 6). Results showed that spatial imagery ratings were not related to representational gestures ($b = 0.001$, 95% CI [-0.11, 0.12], $t = 0.02$, $p = .979$) and total number of details remembered ($b = 0.009$, 95% CI [-0.06, 0.08], $t = 0.25$, $p = .801$). No moderating effect of age was found on the relation between representational gesture ($b = -0.006$, 95% CI [-0.09, 0.07], $t = -0.15$, $p = .880$) or total number of details ($b = -0.003$, 95% CI [-0.05, 0.04], $t = -0.15$, $p = .875$) and spatial imagery ratings. Total number of details remembered did not mediate the effect of gesture production on the phenomenological ratings of spatial imagery, b = -0.002, SE = .018, 95% CI [-0.04, 0.02].

3.3.3 Reliving

The final moderated mediation analysis was conducted to test whether representational gestures relate to reliving ratings via the increase in the total number of details remembered (see Table 7). Neither representational gesture production (b = 0.01, 95% CI [-0.14, 0.17], t = 0.23, p = .814) nor the number of remembered details (b = -0.01, 95% CI [-0.11, 0.08], t = -0.38, p = .699) predicted the ratings of reliving. Age did not moderate the relation between gesture (b = -0.01, 95% CI [-0.12, 0.09], t = -0.24, p = .808) or total number of details (b = 0.02, 95% CI [-0.04, 0.08], t = 0.60, p = .543) and reliving ratings. Also, total number of details remembered did not act as a mediator in the relation between the production of representational gestures and reliving ratings, b = 0.01, SE = 0.02, 95% CI [-0.03, 0.05].

Table 5. Testing the Moderated Mediating Effect of Representational Gesture on Visual Imagery

Predictors	On Total Number of Details				On Visual Imagery			
	B	SE	*P*	95% CI	*B*	SE	*P*	95% CI
Age Group					0.36	0.34	0.293	[-0.32, 1.06]
Representational Gesture	0.72	0.13	0.0000	[0.45, 0.98]	0.08	0.06	0.186	[-0.04, 0.20]
Representational Gesture x Age Group					-0.05	0.04	0.201	[-0.14, 0.03]
Total Number Of Details					0.01	0.03	0.707	[-0.06, 0.09]
Total Number of Details x Age Group					-0.008	0.02	0.735	[-0.05, 0.04]
R^2	0.27				0.04			
F	29.79				0.71			

Table 6. Testing the Moderated Mediating Effect of Representational Gesture on Spatial Imagery

Predictors	On Total Number of Details				On Spatial Imagery			
	B	SE	*P*	95% CI	*B*	SE	*P*	95% CI
Age Group					-0.03	0.34	0.914	[-0.71, 0.64]
Representational Gesture	0.72	0.13	0.0000	[0.45, 0.98]	0.001	0.05	0.979	[-0.11, 0.12]
Representational Gesture x Age Group					-0.006	0.04	0.880	[-0.09, 0.07]
Total Number Of Details					0.009	0.03	0.801	[-0.06, 0.08]
Total Number of Details x Age Group					-0.003	0.02	0.875	[-0.05, 0.04]
R^2	0.27				0.01			
F	29.79				0.15			

Table 7. Testing the Moderated Mediating Effect of Representational Gesture on Reliving

Predictors	On Total Number of Details				On Reliving			
	B	SE	*P*	95% CI	*B*	SE	*P*	95% CI
Age Group					-0.26	0.45	0.563	[-1.18, 0.64]
Representational Gesture	0.72	0.13	0.0000	[0.45, 0.98]	0.01	0.08	0.814	[-0.14, 0.17]
Representational Gesture x Age Group					-0.01	0.05	0.808	[-0.12, 0.09]
Total Number Of Details					-0.01	0.05	0.699	[-0.11, 0.08]
Total Number of Details x Age Group					0.02	0.03	0.543	[-0.04, 0.08]
R^2	0.27				0.01			
F	29.79				0.24			

3.4 Modality through which episodic and non-episodic details are reported

A three-way mixed ANOVA was performed using the detail type (episodic vs. non-episodic), modality (only-verbal vs. verbal+gestural), and age (child vs. adult) to test whether there was a difference in the modality through which episodic and non-episodic details were reported, and whether this difference changed as a function of age[6]. There was a significant main effect of detail type F (1, 79) = 336.73, MSE = 4.11, 95% CI [3.72, 4.62], $p < .01$. Participants reported more episodic details (M = 5.46, SE = .27) than non-episodic details (M = 1.29, SE = .11). There was not a significant interaction effect between detail type and age, F (1, 79) = 3.53, p = .064, $\eta_p^2 = 0.043$.

There was no main effect of modality through which memory details reported, F(1, 79) = .040, MSE = 9.50, 95% CI [-0.61, 0.75], p = .842; however, it was revealed that age had a significant interaction with modality, F (1, 79) = 62.55, $p < .01$. While adults delivered majority of memory details using verbal+gestural utterances ($p < .01$, 95% CI [1.89, 3.70]), children used only-verbal utterances more frequently than verbal+gestural utterances to deliver the details they remembered ($p < .01$, 95% CI [1.62, 3.70]).

Although the modality did not show any interaction with the type of memory details, F (1, 79) = 2.24, p = .138, the three-way interaction between detail type,

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[6] In the child group, to control the effect of wide age range on the interaction between modality and detail type, a 2x2 ANCOVA was conducted, with detail type (episodic vs. non-episodic), and modality (only-verbal vs verbal+gestural) as independent variables, the total number of details reported as the dependent variable, and age as a covariate. The covariate, age range in the child group, was not significantly related to the total number of details reported F(1, 33) = 0.47, p = .495, η_p^2 = 0.014. Both the main effect of modality, F(1, 33) = 10.91, p = .002, $\eta_p^2 = 0.249$, and the interaction of modality and detail type. F(1, 33) = 9.37, p = .004, $\eta_p^2 = 0.221$, were found to be significant, after controlling the effect of age. Post hoc tests using the Bonferroni correction revealed that while reporting episodic details, children used more only-verbal utterances (M = 6.91, SE = 0.48) than verbal+gestural utterances (M = 2.37, SE = 0.40), $p < .001$, 95% CI [3.52, 5.56]. Same modality preference was observed during reporting non-episodic details, yet the difference in the number of details reported via only-verbal utterances (M = 1.29, SE = 0.21) and verbal+gestural utterances (M = 0.50, SE = 0.10), $p < .001$, 95% CI [0.42, 1.15] decreased.

modality and age reached significance, *F* (1, 79) = 46.18, , *MSE* = 4.06, $p < .01$. In reporting episodic details, adults used more verbal+gestural utterances (*M* = 8.28, *SE* = 0.62) than only-verbal utterances (*M* = 4.28, *SE* = 0.35), $p < .01$, 95% CI [2.57, 5.43], while children preferred to use only-verbal utterances (*M* = 6.91, *SE* = 0.41) more frequently than verbal+gestural utterances (*M* = 2.37, *SE* = 0.71), $p < .01$, 95% CI [2.90, 6.18]. While reporting non-episodic details, the same modality preferences were observed yet the difference in the number of details uttered via verbal+gestural utterances and only-verbal utterances both in adult ($p < .01$, 95% CI [1.06, 2.14]) and child group ($p = .013$, 95% CI [0.16, 1.41]) decreased[7]. To conclude, each groups' modality preference was more apparent while reporting episodic details directly related to the recalled event (see Figure 4).

[7] A three-way mixed ANOVA with 81 participants across two groups would be sensitive to effects of Cohen's $f^2 = 0.14$ with 90% power (alpha = .05). The three-way interaction between detail type, modality and age has a large effect size (Salkind, 2010), Cohen's $f^2 = 0.74$. Thus, the current study has decent power to detect the reported three-way interaction (see Appendix F for the sensitivity plot).

Figure 4. Graph of the three-way interaction between age, modality, and detail type

CHAPTER 4
DISCUSSION

This study investigated how representational gestures produced during memory narration related to the content and phenomenology of autobiographical memories and whether age was a factor effecting this potential relation. As a related question, it was investigated whether children and adults used verbal and gestural modalities in combination or in isolation while narrating the events from their past and how their modality preferences related to the episodicity of the material they remembered.

4.1 Representational gestures and autobiographical memory content

While narrating personal past events, people report episodic details directly related to the recalled event, enmeshed within the report is non-episodic details independent from a specific context (Levine et al., 2002; Rubin, 2005; Strikwerda-Brown et al., 2019). Autobiographical memories are more than mere representation of reality; they are actively reconstructed during retrieval by employing a number of cognitive and linguistic processes (Bartoli & Smorti, 2019; Conway et al., 2002; Fivush, 2011; Hassabis et al., 2007; McClelland, 2011; Schacter & Addis, 2007). As an imagistic counterpart to verbal modality, in the current study, representational gestures were shown to help people in reporting episodically rich memories involving more visuo-motoric details.

The current study found that adult memories involved more episodic and non-episodic details than child memories; nevertheless, the amount of visuo-motoric detail was equivalent in adult and child memories. More importantly, there was a positive association between the quantity of episodic and visuo-motoric details recalled in autobiographical memories and the number of representational gestures produced during memory narration. However, gesturing appeared to be related to the amount of episodic and visuo-motoric details in adult memories only; gesturing did not relate to the amount of episodic and visuo-motoric details in child memories, despite the fact that children recalled the very same number of visuo-motoric details as adults. As it was hypothesized, the amount of non-episodic details comprising general facts, extended events, details from other external events, and metacognitive statements was not related to the amount of representational gesture produced during memory narration in both adult and child memories.

Multimodal representations that constitute an autobiographical event are reactivated during retrieval to mimic how the brain portrayed the perceptions, actions, and introspection recorded during the initial encoding (Barsalou, 1988, 2008). Frick-Horbury (2002b) argues that self-generated material like gestures can function as externalized cues as they are a separate representation of semantic knowledge and provide the speaker with additional information about a target by activating the memory trace. Gestures might have provided recallers with additional visual, kinesthetic and bodily cues for the event they were recalling, thus enabling them to draw upon numerous dimensions of the to-be-recalled event (Liwag & Stein, 1995; Madan & Singhal, 2012; Murachver et al., 1996). Current results accord well with these arguments and extend the mnemonic function of gestures to the recall of personal material like autobiographical events.

These results are also consistent with those obtained in enactment studies. In two studies conducted by Wesson and Salmon (2001) and subsequently by Stevanoni and Salmon (2005), it was shown that children provided more detailed and richer event reports when asked to re-enact a previously experienced event or encouraged to use gestures while reporting an event also known to the experimenters. In both studies exploring the mnemonic function of gestures and enactment effect, gestures were only available in the retrieval phase and could acvitate the episodic elements of the previously experienced events. This is similar to the case in the current study, gestures produced during the retrieval phase resulted in autobiographical memory reports rich with episodic, especially visuo-motoric details.

In their gesture for conceptualization framework, Kita et al. (2017) propose that gestures help people to focus on a small fraction of available information, possibly relevant to the task at hand and through this schematization gestures activate, manipulate, package and explore representations spatio-motoric in nature. The current findings showed that adult participants who produced more representational gestures during memory narration reported more visuo-motoric details portraying actions, objects, perceptual states and descriptions experienced in the original event. One supplementary finding that supports the function of representational gestures acting as externalized cues is that when only non-representational gestures were tested for their association with both episodic and visuo-motoric details, it was found that nonrepresentational gestures, having no discernible semantic relation to accompanying verbal utterances, were not associated with episodic and visuo-motoric details (see Appendix H for the supplementary analyses conducted with nonrepresentational gestures). These supplementary findings support the claims of gesture for conceptualization hypothesis within the context of autobiographical memories. In the case of reporting multimodal past events, gestures may have helped recallers to conceptualize their memory contents by activating new visuo-motoric representations or maintaining the activation of already activated ones; by rearranging, rotating, inverting or taking a new perspective on visuo-motoric representations they recalled; by linearizing visuo-motoric information they remembered into verbalizable chunks; and finally, by helping recallers to explore various possibilities for what information to report (see Kita et al., 2017).

Non-episodic details reported during memory narration had no relationship with the amount of representational gestures produced as compared to episodic and visuo-motoric details. When the same analyses that were conducted with representational gestures and memory content were repeated with total gesture amount by incorporating nonrepresentational gestures (see Appendix G for the supplementary analyses conducted with total gesture count) or solely by nonrepresentational gestures (see Appendix H), it was revealed that non-episodic details, lacking visuo-motoric features or a specific scene, only increased when memory reports were accompanied by nonrepresentational gestures. In comparison to representational gestures which might act as nonverbal cues activating episodic as well as visuo-motoric details, nonrepresentational gestures were assumed to serve meta-cognitive functions by marking the word or concept that the speaker intends to stress (McNeill, 1992; So et al., 2012). Participants, especially adults, were more prone to provide general facts or metacognitive statements in which they expressed the meanings they had derived from reported events; thus, it seems that the emphasis adults had put on certain non-episodic details had been accompanied by nonrepresentational gestures.

4.2 The mechanism behind the relation between gesturing and autobiographical memory content

When representational gestures accompanied memory narration, rather than acting as externalized cues and activating memory details, the gestures may have assisted the speech production process by increasing the speaker's access to lexical items, packaging visuo-motoric information into verbalizable chunks, and overall reducing the cognitive load of verbal reporting, allowing cognitive resources to be allocated to the retrieval of episodically rich memories (Alibali et al., 2000; de Ruiter, 2000; Goldin-Meadow et al., 2001; Hadar & Butterworth, 1997; Kita, 2000; Krauss, Chen, & Chawla, 1996; Krauss, Chen, & Gottesman, 2000; Rauscher et al., 1996; Wesp et al., 2001). In order to address this possibility, the speechrate (the number of words spoken per minute) was calculated for each memory recalled, and a post-hoc analysis was carried out to see whether representational gestures produced during memory narration positively relate to episodic details by increasing the speechrate, presumably as an indicator of a corresponding decrease in the cognitive load of verbal reporting[8]. Even though representational gesture production was associated with higher speech rate, speechrate did not operate as a mediator in the relationship between representational gestures and remembered episodic details.

Narratives are made up words, yet their meaning is an emergent quality that can not be ascribed to word choice (Adler et al., 2017). Accordingly, the structure of

[8] The current moderated mediation analysis tests whether representational gestures produced during memory narration positively relate to episodic details by increasing the speechrate, presumably as an index of a corresponding decrease in the cognitive load of verbal reporting. As participants produced more representational gestures during memory narration, their speechrate increased, $b = 1.40$, 95% CI [0.51, 2.28], $t = 3.15$, $p = .002$. However, results revealed that speechrate is not a mediator in the relation between representational gestures and the number of episodic details recalled, $b = -0.003$, SE = .08, 95% CI [-0.16, 0.17].

narratives is analyzed at both micro and macro levels. At the micro level, cohesion is the key term and it refers to the various ways in which the components of a text are linked together (e.g., grammatical, lexical, semantic). It is commonly evaluated phrase by phrase within sentences, without consideration for how they relate to the text as a whole. Coherence, at the macro level, offers the narrative content with a schematic organization and meaningfully connects the various components of the narrative (Berman & Slobin, 1994). Thus, gestures might positively relate to the episodicity of autobiographical narratives via micro level features but also via macro level features indicating narrative quality such as grammatical comlexity (e.g, Jenkins et al., 2017) or coherence (e.g., Demir et al., 2015; Parrill et al., 2018; Reese et al., 2011; Vanderveren et al., 2019). Thus, if gestures contribute to autobiographical memory narration through their linguistic functions, this possibility should be tested via narrative indices at both the micro and macro level.

Another possibility is that gesturing during memory narration may have helped recallers to construct mental models of the previously experienced scenes (Ping & Goldin-Meadow, 2010). When recalling past events, scenes are created to package relevant semantic, contextual and sensorial components (Hassabis et al., 2007; Wheeler et al., 2000). In the present study, it was observed that most of the deictic gestures produced during memory narration were indexing the places of people or objects in the original event. However, there is no evidence that participants experienced a scene in which they could place themselves in relation to recalled details like actions, objects, or other people. Adapting the procedure used in several studies (e.g., Rubin et al., 2019), participants could be asked to rate whether they had experienced a scene in which the elements of the recalled setting were located relative to each other in space on a scale ranging from “not at all spatially organized” to “a clear spatial layout”. Then this rating score could be tested as a mediator in the relation between gestures and episodic details recalled. Further work is needed to determine the exact mechanism through which gestures contribute to autobiographical memory content.

4.3 Developmental differences in the relation between representational gestures and autobiographical memory content

Children's autobiographical memories improve remarkably until the age of ten, and children report longer, thematically, chronologically and causally coherent memories with many episodic details (Bauer & Larkina, 2019). Even at ten years of age, however, children's autobiographical memory reports are not as long, coherent, or episodically rich as adult memories (Bauer & Larkina, 2019; Reese et al., 2011). Based on the differences in neurological and cognitive processes involved in autobiographical memory retrieval (Bauer, 2015; Bauer et al., 2016; Bauer & Larkina, 2019) and the greater narrative complexity of adult memories (Nicoladis et al., 2016) it was hypothesized that adults would use gestures more efficiently and the hypothesized association between representational gestures and episodic as well as visuo-motoric details would be stronger in the adult group. Adult representational gestures were found to be positively associated with both episodic and visuo-motoric details; however, similar associations were not found in child memories, confirming the moderatory role of age.

Autobiographical memory retrieval is a cognitively demanding task, and children's cognitive resources may be insufficient for supporting retrieval processes and subsequently communicating these recalled events via multimodal channels.

According to Conway and Pleydell-Pearce (2000), memory retrieval occurs by the cyclic access and evaluation of autobiographical knowledge base comprised of three broad levels of specificity arranged from the conceptul and abstract to very specifics of single episodic events. For example, a person requested to recall a memory to the cue word Sea, would first expand this into a generic event cue like "Where did I go on my summer vacation last year?" And then obtain the information "Muğla," and use that knowledge to start a new search cycle, and so on, until a specific event is retrieved. Throughout this iterative retrieval phase, central executive processes regulate access to this complex autobiographical knowledge base and adjust output from it (Conway, 1996). Several neuroimaging experiments of autobiographical memory retrieval support this claim, with extensive activation of regions in the left frontal and anterior lobes, indicating that central executive control processes are involved in autobiographical memory retrieval (Conway et al., 1999, 2001; Nolde et al., 1998).

Following the memory retrieval phase, participants in the current study needed to narrate their memories using speech and commonly gesture (but not necessarily), thus recruiting visual and verbal channels. Using speech in conjunction with gesture requires the execution and coordination of both speech and gesture modalities, along with constant updating and preservation of information across the modalities (Cocks et al., 2011). More specifically, Bergmann et al. (2013) proposed a multimodal communication model that includes three stages: (1) conceptualization, during which a message generator and an image generator work together to specify and organize information that has to be encoded in corresponding modalities; (2) formulation, during which speech and gesture formulators determine the appropriate verbal and gestural forms; and (3) execution, during which the intended message is conveyed in utterances by gestures and speech. While these processes are being executed, the communicative intention in the generators must also be kept available, increasing the cognitive demand much more. Considering all of these, while narrating their memories in a multimodal way, participants must clearly outline which information will be conveyed by which channel and with how many clauses. Then they must choose the most appropriate verbal and visual forms corresponding to the referent they want to utter, as well as know how to perform them. Meanwhile, the most suitable semantic and temporal synchrony between gesture and speech should be established by continuous updates and exchanges while keeping the retrieved specific event in mind (Cocks et al., 2011; Kita & Özyürek, 2007).

There are number of studies showing that gesturing decrease cognitive load in dual-task paradigms, which required participants to complete a primary task of spatial or mathematical problem solving while also completing a secondary task of recalling letters, words, or numbers (Hostetter & Alibali, 2008; Paas & Sweller, 2012; Ping & Goldin-Meadow, 2010). However, as Overoye and Wilson (2020) found in a recent study, gesturing may also increase the load in specific situations, such as in a verbal analogy task. The findings of this study showed that gestures produced while discussing verbal analogies (e.g., "Hat is to head as roof is to...") did not free up working memory resources, and participants performed worse on a secondary task requiring them to memorize six pseudorandom numbers. The authors proposed that participants may have used cognitive resources to construct visuospatial representations inherent in the analogy content, which depended on a variety of relationships between analogous items, including color, form, movement, and spatial relationships. Thus, in the context of verbal analogies, embodied visuospatial and motor representations generated for gesturing could add extra burden to the cognitive system (Overoye & Wilson, 2020). A similar argument might be proposed for the current null findings found in the child data. Autobiographical memories are multimodal constructions with a wide range of episodic details; thus, while retrieving and reporting these multimodal constructions, cognitive resources may fall short of supporting both memory-specific representations and the representations employed in gesture production.

4.4 Gestures and phenomenology of autobiographical memories

It was expected that gesturing during memory narration would help people to recollect more details which in turn would help people to relive the recalled past event with its visual and spatial properties. Results of the current study showed that representational gesture production during memory narration allowed people to remember more details about past events, however, this increase in the total number of remembered details did not boost the phenomenological experience of visual imagery, spatial imagery and reliving. Also no moderating role of age was noted in the results.

Phenomenal properties like recollection are considered to distinguish autobiographical memory from other types of memory (Tulving, 2002; Greenberg & Rubin, 2003). Sutin and Robins (2007) define phenomenology as a cognitive component of memory retrieval; however, as pointed out previously, there is little published data on basic cognitive processes underlying the phenomenology of autobiographical memories and the majority of available studies concentrate on visual imagery processes (see Greenberg & Knowlton, 2014; Rubin, Burt, & Fifield, 2003; Rubin, Schrauf, & Greenberg, 2003). One exception is a study that investigated the role of processing speed in the vividness of recalled memories, and it found that while people with greater processing speeds evaluate their memories to be more accessible, those memories are not evaluated as more vivid (Sutin et al., 2021). Therefore, it seems that the empirical evidence showing the cognitive correlates of autobiographical memory is insufficient to support our claim that gestures, as nonverbal tools derived from visuo-spatial representations, are related to phenomenology.

A potential explanation for the failure to find an indirect association between gesturing and phenomenological aspects of autobiographical memory, despite the increase in the total number of recalled details, might be that non-cognitive psychological processes may underlie phenomenology. Phenomenological experience reflects both memory specific features such as emotional intensity and recency of the recalled event as well as individual differences in emotional processing, personality traits, attachment styles and well-being. For example, recent memories have stronger phenomenological properties than remote memories (Luchetti & Sutin, 2018) or emotional memories receive higher phenomenal ratings than neutral memories (Comblain et al., 2005; Destun & Kuiper, 1999). In the current study, the recency or emotionality of the recalled events may have an effect on the phenomenological ratings beyond the effect of gesture production. Personality traits of the recallers, for example being neurotic, extraverted or conscientious, also affect the subjective experience of memories (Blagov et al., 2022; Rubin & Siegler, 2004). Similarly, people having higher attachment avoidance report emotional memories with less recollection (Boyacıoğlu & Sümer, 2011). In the present study, there is also no information about participants' personality traits or attachment patterns, and all these emotional and personal factors might have influenced the phenomenology of recalled memories.

A limited number of studies in memory literature compared the phenomenological experience of autobiographical memories in children and adults, and it was revealed that adolescents and young adults have more similarities than differences in phenomenal characteristics (Bauer et al., 2016). Consistent with this finding, the present study found that children and adults have comparable subjective experience on visual imagery, spatial imagery and reliving. Scarcity of phenomenological studies comparing adults and children and the developmental differences in autobiographical memory and gesture use made it difficult to interpret current null findings about the moderating role of age on the relation between gesturing and phenomenological experience. It is possible that both memory specific features such as emotional intensity and recency as well as individual differences in non-cognitive psychological processes might have affected the phenomenological experience of child participants.

4.5 The use of verbal and gestural modalities in the narration of autobiographical memories

Growing verbal skills does not rule out the fact that children express a considerable portion of their knowledge in a multimodal manner, combining verbal and gestural channels (Alibali & Goldin-Meadow, 1993; Church & Goldin-Meadow, 1986; Pine et al., 2004). Indeed, it has been demonstrated that the frequency and complexity of gestures used by adults and school-aged children are substantially correlated with the frequency and complexity of the verbal language they use (Colletta et al., 2010; Mayberry & Nicoladis, 2000; Nicoladis et al., 2016). Considering the narrative nature of autobiographical memories and the substantial progress children make in narrative production during middle childhood and early adolescence (Aksu-Koç, 1994; Aksu-Koç & Stutterheim, 1994; Ögel-Balaban & Aksu-Koç, 2020; Ögel-Balaban & Hohenberger, 2020), it was expected that adults and children would incorporate gestural modality into verbal modality while narrating their memories, beyond that, as a result of greater complexity of adult memories, adults' reliance on simultaneous use of both modalities was expected to be greater. Moreover, in comparison to non-episodic details, episodic details which have visuo-motoric nature and potentially originating from a spatial event layout were expected to be uttered via multimodal utterances using gestural and verbal channels.

The findings partially confirmed the predictions, showing that adults frequently combined verbal and gestural modalities when reporting episodic details; however, contrary to expectations, child participants solely used verbal modality to report episodic details. When reporting non-episodic details, adults' tendency to use gestural modality along with verbal modality was notable again yet it declined, which is consistent with the hypothesis. Similarly, children's tendency to use verbal modality in the absence of gestural modality was also noted while reporting non-episodic details, though at a lower rate than when reporting episodic details. To put it more clearly, while adults preferred multimodal utterances in reporting autobiographical events, children preferred unimodal verbal utterances. Further, each group's modality preference was more noticeable when reporting episodic details directly related to the recalled events.

These results partially differ from previous studies exploring multimodal narratives of school aged children and adults speaking different languages (e.g., Colletta et al., 2010, 2015; Graziano, 2009; Nicolas et al., 2017). In the given studies, it was shown that as narratives get longer and more complicated, both adults and children use gestural and verbal modalities together. In the present study, only adults combined gestural modality with verbal modality when narrating autobiographical events. A possible explanation for children’s exclusive use of verbal modality in the absence of gestural modality might be that children’s autobiographical narratives were low in narrative lenght. In a study by Nicoladis et al. (2016), it was shown that the lenght of stories (number of word tokens) was a better predictor of how frequently children gestured in a contex in which they retold the cartoons they had previously watched. Post-hoc analyses showed that adult memories were twice as long as those of children, and the frequency of representational gesture was associated with the lenght of autobiographical narratives only in the adult group[9]. Thus, one reason for childrens’exclusive use of verbal modality might be that their memories are not long enough to utter some details using gestures.

Alternatively, it is possible that visuo-spatial imagery processes were not active enough during children's memory narration, and the scarcity of visuo-spatial content might not necessitate the use of gestural modality. Nicoladis et al. (2016) propose that one another predictor of gesture frequency in children’s narrative retelling is their active use of visuo-spatial imagery. Previous research in gesture literature also consistently revealed that people are more inclined to gesture while conveying spatial information than when conveying non-spatial information (Alibali, 2005; Arslan & Göksun, 2021; Chu & Kita, 2011; Feyereisen & Havard, 1999; Kita

[9] An independent samples t-test comparing the number of word tokens uttered across the recalled memories showed that adults (M = 103.51, SD = 51.07) produced longer autobiographical narratives than children (M = 48.54, SD = 31.76), $t(79) = 5.59$, 95% CI [35.40, 74.53], $p < .001$. Bivariate correlations revealed that representational gesture frequency and the narrative lenght were only associated in the adult group ($r = .490$, $p = .001$) not in the child group ($r = -.057$, $p = .744$).

& Özyürek, 2003; Rauscher et al., 1996). Though the majority of cue-words used in the memory retrieval were chosen from a set of cue-words with higher imagery ratings, it was still unclear how much visuo-spatial content they activated in recallers. In order to address this issue, different retrieval contexts that require visual, spatial, and motor imagery could be created. For example, participants might be asked to recall memories presumably rich in visuo-spatial content (e.g., "Could you remember one time you got lost?", "Could you remember the day you first rode a bike?", "Could you remember the day you took the driving test?", "Could you remember the day you first learnt to swim?"). Then it might be compared how these visuo-spatially rich memories are reported using verbal and gestural modalities in comparison to the ones more abstract in nature ("Could you remember an event that made you very happy?").

4.6 Limitations and future directions

The major limitation of this study is that it was correlational; thus, verification of present conclusions require converging evidence from experimental studies that control the gesturing behavior or the visuo-motoric content elicited in memories. For example, assigning participants to narrate autobiographical events in gesture-allowed and gesture-not-allowed conditions might help us to see how gesturing contributes to the episodic and non-episodic content of memories as well as its phenomenology. Future studies could also create different retrieval contexts that compare how visually, spatiall or motorically rich memories relate to gesturing in comparison to the ones more abstract in nature. Gesture production and its influence on autobiographical memory might differ depending on the context, and the association between gesturing behavior and memory might be more pronounced while reporting a memory high on visuo-spatial content.

4.7 Conclusions

The most obvious finding to emerge from this study is that gestures are related to the retieval of episodically rich memories that involve more visuo-motoric details in adults but not in children. Second, adults exploit the expressive capabilities of gestural and verbal modality in narrating episodic details directly related to recalled events, whereas children employ unimodal utterances constructed exclusively using speech. Mnemonic function of gesturing behavior on impersonel material was previously established (Aussems & Kita, 2017; Church et al., 2007; Cook et al., 2010; Riseborough, 1981; So et al., 2012; Tellier, 2008; Thompson, 1995), and with the current findings, the mnemonic function of gestures was extended to a new context entailing the recall of personal material.

APPENDIX A

ETHICS COMMITTEE APPROVAL

T.C.

BOĞAZİÇİ ÜNİVERSİTESİ

Sosyal ve Beşeri Bilimler Yüksek Lisans ve Doktora Tezleri Etik İnceleme Komisyonu

Sayı: 2019-04

4 Şubat 2019

Naziye Güneş Acar

Psikoloji

Sayın Araştırmacı,

"Görme Engelli ve Gören Çocuklarda Otobiyografik Bellek: Zihinde Canlandırma Becerisinin ve Jest Kullanımının Katkısı" başlıklı projeniz ile ilgili olarak yaptığınız SBB-EAK 2019/09 sayılı başvuru komisyonumuz tarafından 4 Şubat 2019 tarihli toplantıda incelenmiş ve uygun bulunmuştur.

Dr. Öğr. Üyesi İnci Ayhan

Prof. Dr. Feyza Çorapçı

Doç. Dr. Mehmet Yiğit Gürdal

Doç. Dr. Ebru Kaya

Dr. Öğr. Üyesi Şebnem Yalçın

APPENDIX B

MEMORY CONTENT CODING: NON-EPISODIC DETAIL EXAMPLES

Category	Explanation	Example
External Event Details	Specific details from incidents other than the main event recalled.	1. Last year, I got the highest point in the English exam, it also happened this semester.
Semantic Information	General knowledge or facts, ongoing events, extended states of being	1. My uncle is a butcher… 2. It was the first time my entire family had gone on a picnic together, my grandfather was used to work very hard.
Repetition	Repetition of details	1. I purchased a book online, then came the small size of the book. I assumed it was big, but it was actually quite small. And then I was disappointed since it was such a small thing.
Other	Metacognitive statements, editorializing	1. It was a turning point in my life… 2. I remember all those days positively…

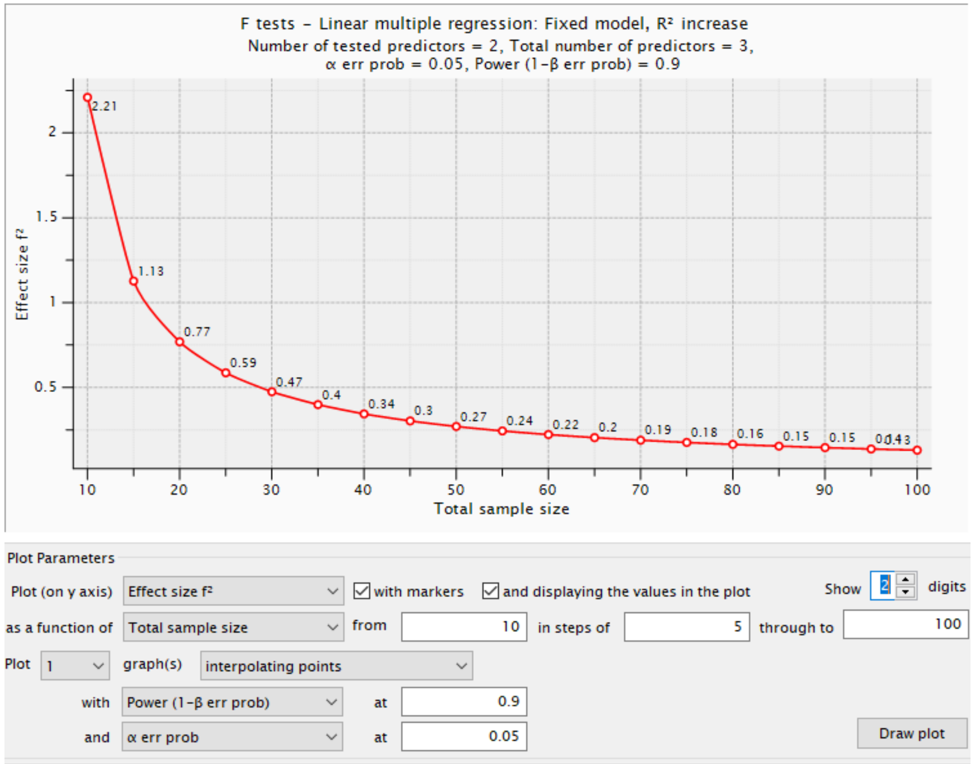
APPENDIX C

MEMORY CONTENT CODING: EPISODIC DETAIL EXAMPLES

Category	Explanation	Example
Who	Specific people participating in the event	1. My uncle arrived.
What-Object	Specific objects that were present or were being acted upon during the event	1. There were nails in the ground.
What-Action	Activities performed by a character or an object	1. I jumped down from the wall. 2. The ball hit the child in the head.
Where	The event's location or a preposition indicating location (e.g., "in," "on top of")	1. We went to the neighbor's house and played in the yard.
When	Time reference, including the placement of the event in time (day of week, season, or time of day) and an indication of the order of specific events within an experience	1. In the morning we went for a walk and then went to a movie. 2. While I was in highschool…
Why	Justification or statement of causation (e.g., "because," "in order to")	1. I kept my shoes hidden because I didn't want my mother to give them to my cousin.
How-Description	An adverb, adjective, another modifier, or a prepositional phrase used to decribe an object or action.	1. I was wearing a yellow vest. 2. Her bike was completely covered with mud.
How-Evaluation	Acknowledgement of personal evaluation of the event, for example, through use of an intensifier (e.g., "most," "greatest"), use of a subjective modifier (e.g., "it was awful") or indication of internal state (any term indicating emotions, cognitions, plans, expectations, wishes, obligations etc).	1. I was so happy / because I had always wanted a Gameboy. 2. I was expecting a perfect school report but… 3. I had to get to a place in time
Event	Happenings, collectively performed events with a specific event scheme	1. We had a theatre play. 2. Our team attended a debate championship. 3. There was a circumcision feast.
Perceptual	Details in auditory, olfactory, tactile, taste, and visual perception, as well as body position.	1. I heard my daddy's voice. 2. My shoes were killing me. 3. There came the smell of freshly baked bread.

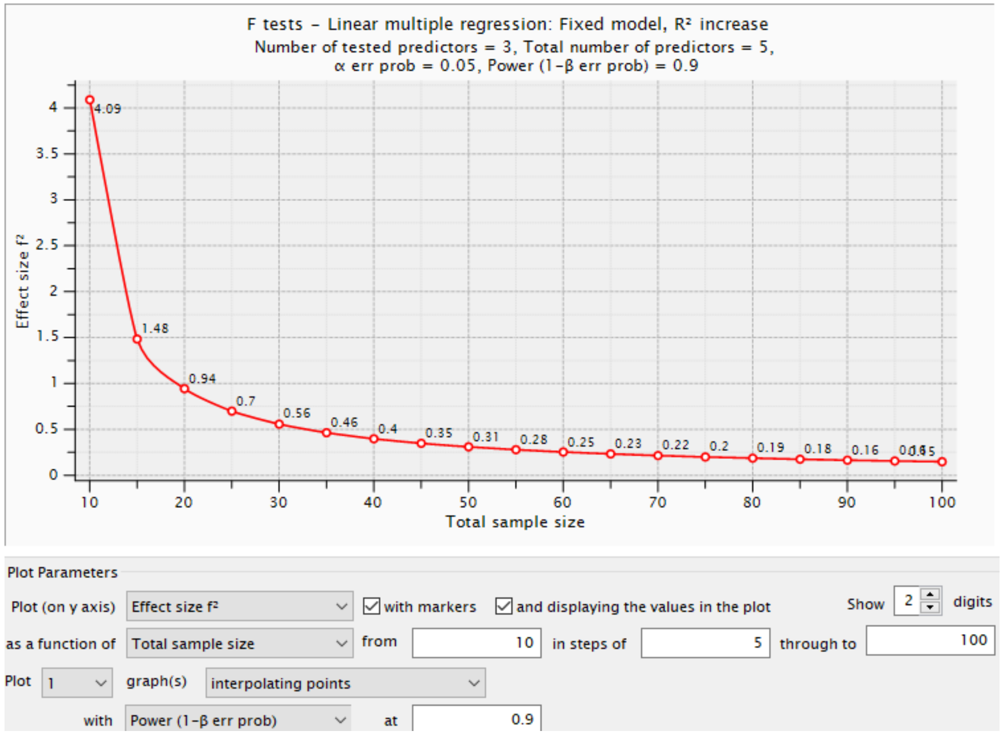
APPENDIX D

SENSITIVITY POWER ANALYSIS PLOT: MODERATION ANALYSES



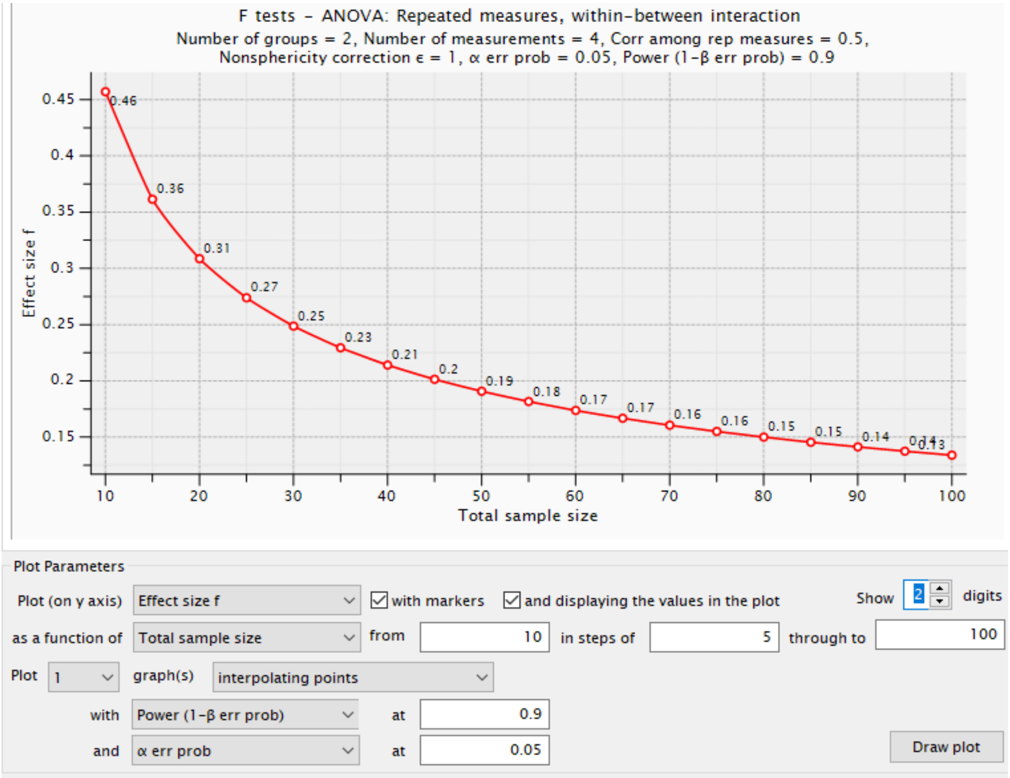
APPENDIX E

SENSITIVITY POWER ANALYSIS PLOT: MODERATED MEDIATION ANALYSES



APPENDIX F

SENSITIVITY POWER ANALYSIS PLOT: MIXED ANOVA ANALYSIS



APPENDIX G

SUPPLEMENTARY ANALYSES: NONREPRESENTATIONAL GESTURE

1. Nonrepresentational gestures and autobiographical memory content

Three moderation analyses were conducted using SPSS PROCESS macro (Model 1) by Hayes (2013). Each of the moderation analysis tested the age dependent relation between nonrepresentational gestures and one of three components of memory content: episodic details, visuo-motoric details, and non-episodic details.

In predicting the total number of episodic details about the recalled events, nonrepresenttaional gestures produced during memory narration and age explained a significant amount of variance, $F(3, 77) = 2.87$, $p = .041$, $R^2 = .10$. However, nonrepresentational gestures ($p = .983$) and age ($p = .130$) were not significant predictors of the number of episodic details reported. Similarly, the interaction between nonrepresentational gesture and age was not significant ($p = .967$).

Another moderation analysis was performed to determine whether nonrepresentational gestures produced during memory narration activated visuo-motoric details such as actions, objects, descriptions, and perceptual states differently in children and adults. Nonrepresentational gestures and age explained only 4.77% of the variance in visuo-motoric details one reported in an event, $F(3, 77) = 1.28$, $p = .285$.

Lastly, nonrepresentational gestures produced during memory narration and age explained a significiant amount of variability in the number of non-episodic details one reported, $F(3, 77) = 4.39$, $p = .006$, $R^2 = .146$. Individual predictors, nonrepresentational gestures (p = .224) and age (p = .453), as well as the interaction between them (p = .218) were not significantly related to the non-episodic details.

2. Nonrepresentational gestures and autobiographical memory phenomenology

Three moderated mediation analyses were performed using SPSS PROCESS macro (Model 15) by Hayes (2013). Each moderated mediation analysis tested whether nonrepresentational gestures relate to one of three phenomenological ratings: visual imagery, spatial imagery, and reliving by increasing the total number of details remembered, and whether this mediation effect differs statistically between children and adults.

The current analysis tests whether nonrepresentational gestures relate to visual imagery ratings by increasing the total number of details remembered and whether this mediation effect holds for both children and adults. Nonrepresentational gestures did not lead people to report more details about the recalled events, b = 0.19, 95% CI [-0.08, 0.46], t = 1.35, p = .178. Results also revealed that nonrepresentational gestures and age did not explain a significant amount of variance in visual imagery ratings, $F(5, 75) = 1.52$, p = .190, R^2 = .092.

A second moderated mediation model was run to see whether participants' phenomenological experience of spatial relations in their memories was related to nonrepresentational gestures via the increase in the total number of details remembered. Overall model, predicting spatial imagery ratings from nonrepresentational gestures via the total number of details remembered, was not significant, $F(5, 75) = 1.07$, p = .378, R^2 = .067. Age also did not function as a moderator, b = 0.009, 95% CI [-0.04, 0.06], t = 0.33, p = .736.

The final moderated mediation analysis was conducted to test whether nonrepresentational gestures relate to reliving ratings via the increase in the total number of details remembered. Similar to the case in visual imagery and spatial imagery ratings, the overall model was not significant, $F(5, 75) = 0.37$, $p = .861$, $R^2 = .024$. Age also did not function as a moderator, $b = 0.013$, 95% CI [-0.06, 0.08], $t = 0.36$, $p = .713$.

APPENDIX H

SUPPLEMENTARY ANALYSES: TOTAL GESTURE

1. Total number of gestures and autobiographical memory content

Three moderation analyses were conducted using SPSS PROCESS macro (Model 1) by Hayes (2013). Each of the moderation analysis tested the age dependent relation between total number of gestures and one of three components of memory content: episodic details, visuo-motoric details, and non-episodic details.

In predicting the total number of episodic details about the recalled events, the total number of gestures produced during memory narration and age explained a significant amount of variance, $F(3, 77) = 6.53$, $p = .0005$, $R^2 = .20$. The relationship between total number of gestures and episodic details was moderated by age, $b = -0.32$, 95% CI [-0.61, -0.02], $t = -2.13$, $p = .035$. In the adult group, the increase in the total number of gestures was associated with the recall of more episodic details, $b = 0.31$, 95% CI [0.11, 0.51], $t = 3.14$, $p = .0024$. However, in the child group, the total number of episodic details did not increase as children's gesturing frequency increased, $b = -0.002$, 95% CI [-0.22, 0.21], $t = -0.021$, $p = .982$.

Another moderation analysis was performed to determine whether total number of gestures produced during memory narration activated visuo-motoric details such as actions, objects, descriptions, and perceptual states differently in children and adults. Total number of gestures and age explained 13.54% of the variance in visuo-motoric details one reported in an event, $F(3, 77) = 4.02$, $p = .010$. Overall, as total gesture production increased, so did the number of visuo-motoric details, $b = 0.36$, 95% CI [0.06, 0.66], $t = 2.46$, $p = .016$. The relation between gesture production and visuo-motoric details did not change as a function of age, b = -0.18, 95% CI [-0.37, 0.01], t = -1.88, p = .063.

Lastly, total number of gestures produced during memory narration and age explained a significiant amount of variability in the number of non-episodic details one reported, $F(3, 77) = 5.64$, p = .0015, R^2 = .18. As gesture production increased, participants reported more non-episodic details, b = 0.21, 95% CI [0.01, 0.41], t = 2.16, p = .033. Age did not function as a moderator in the relation between gesture and the number of non-episodic details reported, b = -0.12, 95% CI [-0.25, 0.004], t = -1.92, p = .057.

2. Total number of gestures and autobiographical memory phenomenology

Three moderated mediation analyses were performed using SPSS PROCESS macro (Model 15) by Hayes (2013). Each moderated mediation analysis tested whether total number of gestures relate to one of three phenomenological ratings: visual imagery, spatial imagery, and reliving by increasing the total number of details remembered, and whether this mediation effect differs statistically between children and adults.

The current analysis tests whether total number of gestures relate to visual imagery ratings by increasing the total number of details remembered and whether this mediation effect holds for both children and adults. In line with the predictions, as participants produced more gestures during memory narration, they reported more details about the recolled events, b = 0.29, 95% CI [0.13, 0.45], t = 3.72, p = 0.0004. However, results revealed that total gesture production (b = 0.02, 95% CI [-0.03, 0.09], t = 0.85, p = .394) and total number of details remembered (b = 0.03, 95% CI [-0.03, 0.10], t = 1.05, p = .295) were not significant predictors of visual imagery ratings. Age did not have a moderating effect on the relation between total number of gestures (*b* = -0.02, 95% CI [-0.06, 0.01], *t* = -1.34, *p* = .183) or total number of details (*b* = -0.02, 95% CI [-0.06, 0.02], *t* = -0.86, *p* = .391) and visual imagery ratings. Moreover, the results revealed a non-significant moderated mediation effect, *b* = -0.006, SE = .0054, 95% CI [-0.01, 0.004].

A second moderated mediation model was run to see whether participants' phenomenological experience of spatial relations in their memories was related to total number of gestures via the increase in the total number of details remembered. Results showed that spatial imagery ratings were not related to total gesture production (*b* = -0.02, 95% CI [-0.09, 0.03], *t* = -0.91, *p* = .361) and total number of details remembered *(b* = 0.02, 95% CI [-0.04, 0.09], *t* = 0.71, *p* = .473). No moderating effect of age was found on the relation between total number of gestures (*b* = 0.007, 95% CI [-0.03, 0.04], *t* = 0.39, *p* = .694) or total number of details (*b* = -0.01, 95% CI [-0.05, 0.03], *t* = -0.50, *p* = .613) and spatial imagery ratings. Total number of details remembered did not mediate the effect of total gesture production on the phenomenological ratings of spatial imagery, *b* = -0.005, SE = .005, 95% CI [-0.01, 0.006].

The final moderated mediation analysis was conducted to test whether total gesture production relates to reliving ratings via the increase in the total number of details remembered. Neither gesture production (*b* = -0.01, 95% CI [-0.10, 0.06], *t* = -0.36, *p* = .717) nor the number of details (*b* = -0.006, 95% CI [-0.09, 0.08], *t* = -0.14, *p* = .885) predicted the ratings of reliving. Age did not moderate the relation between gesture (*b* = 0.005, 95% CI [-0.04, 0.05], *t* = 0.20, *p* = .837) or total number of details (*b* = 0.01, 95% CI [-0.04, 0.07], *t* = 0.43, *p* = .666) and reliving ratings. Also, total number of details remembered did not act as a mediator in the relation between gesture production and reliving ratings, $b = -0.003$, SE = .006, 95% CI [-0.01, 0.01].

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