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“TOT” phenomena: Gesture production in younger and older adults

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Abstract

This study explored age-related changes in gesture in order to better understand the relationship between gesture and word retrieval from memory. The frequency of gestures during "Tip-of-the-Tongue" (TOT) states highlights this relationship. There is a lack of evidence describing the form and content of iconic gestures arising spontaneously in such TOT states, and a parallel gap addressing age-related variations. In this study, TOT states were induced in 45 participants from two age groups (older and younger adults) using a pseudoword paradigm. The type and frequency of gestures produced was recorded during two experimental conditions (single-word retrieval/ narrative task). We found that both groups experienced a high number of TOT states, during which they gestured. Iconic co-TOT gestures were more common than non-iconic gestures. Whilst there was no age-effect on the type of gestures produced, there was a significant, task-specific, age difference in the amount of gesturing. That is, younger adults gestured more in the narrative task, whereas older adults generated more gestures on the single-word retrieval task. Task-specific age differences suggest that there are age-related differences in terms of the cognitive operations involved in TOT gesture production.

Keywords: Aging; Cognition; Gesture production; Language; Tip-of-the-Tongue

Word count = 5597 words

Introduction

Gestures are limb and body movements made to express (or help express) meaning or to emphasize speech. They often support and are synchronised with speech. Their contribution to communication has attracted increasing attention in the literature. Specifically, it has been argued that gestures encompass the motoric components of a word in memory (Frick-Horbury & Guttentag, 1998). For example, when we think about the word "hammer", its motoric image, portraying its structure and function, precedes its verbal production (Frick-Horbury & Guttentag, 1998). Processing activates these mental representations as part of the word's meaning (Saltz & Donnenwerth-Nolan, 1981; Klatzky, Pellegrino, McCloskey, & Doherty, 1989).

The frequency of gestures during tip-of-the-tongue (hereafter TOT) states has led some researchers to believe that gestures facilitate lexical retrieval (Hadar & Butterworth, 1997; Rauscher, Krauss, & Chen, 1996). Speakers have been found to gesture more when describing spatial content (Rauscher et al, 1996) and when such content must be recalled from memory, leading researchers to concluded that gesture either helps to maintain spatial information in spatial working memory (Wesp et al., 2001; De Ruiter, 1998) or that it activates key spatio-motoric information in the semantic representation of the searched-for word (Morsella and Kraus, 2004). However, the need to maintain spatial information in spatial working memory is decreased when a visual image is provided (Morsella and Kraus, 2004; Wesp et al., 2001; De Ruiter, 1998) or when the information is coded verbally (Wesp et al 2001).

The research on the role of gesture production in TOT states has mainly explored the impact of restricting gesture production. Findings of these studies have been conflicting. Frick-Horbury and Guttentag (1998) found that when participants could

gesture they recalled more words, but there was no increase in the number of TOT states that were resolved. In contrast, Beattie and Coughlan (1999) found that when participants were free to gesture there was no increase in the number of words recalled but those who were free to gesture were more likely to resolve TOT states than those whose gesture was restricted. The reasons for these different findings are difficult to determine but suggest that research using different methodologies is needed to understand the role of gesture in lexical retrieval.

Aging has been claimed to either affect cognition globally or to affect specific components of the cognitive system, such as working memory. This study explored age-related changes in gesture in order to better understand the relationship between gesture and the lexical retrieval processes inherent in TOT states. It is possible that gesture depicts or maintains the motoric image of the word that the speaker is trying to retrieve when the working memory system is under pressure. Indeed related evidence exists about the role of gesture when the language processing system is under pressure from language impairment due to stroke (aphasia). Cocks, Dipper, Prichard, and Morgan (2013) found a high prevalence during word-searching behaviour by people with aphasia of gestures that depicted the shape of an object (which they refer to as "shape outline" gestures) and gestures that depicted the "manner" of action. Thus, as suggested earlier, gesture appears to depict motoric information about the structure and the function of the word that the speaker is trying to retrieve. They also found that the form of gestures produced during fluent speech differed to that produced during word-searching, highlighting that the gesture produced alongside TOT states is distinctive.

No previous research has analysed the form of gestures produced by healthy participants when in a TOT state. One reason for this omission is that TOT states rarely occur spontaneously, perhaps as infrequently as once a week (Cocks et al., 2013; Brown, 1991). However, TOT states increase with age (Burke, MacKay, Worthley, & Wade, 1991) and so one method for exploring the types of gestures used by healthy participants would be to explore gesture use during TOT states by older adults.

Despite evidence that TOT states increase with age (Burke, MacKay, Worthley, & Wade, 1991), no studies have investigated the impact of aging on the gesture which often accompanies such states (co-TOT gestures). Co-TOT gestures are a type of iconic gesture, which are those gestures which depict semantic information typically about the shape or function of the object. Although the relationship between gestures and aging is not well documented, and there is no evidence about co-TOT gesture specifically, there is some evidence to suggest that older adults use less iconic gesture (Cohen & Borsoi, 1996; Feyereisen & Harvard, 1999). This may be due to a reduced use of visual imagery, general decline in physical activity, and/or decreased flexibility and control of the small movements required for gestures (Cohen & Borsoi, 1996; Feyereisen & Havard, 1999; Gullberg, de Bot, & Volterra, 2008).

Gesture is of interest because of what it can reveal about spoken language processing in ageing, especially lexical retrieval. Evidence exists, on the one hand, about the relatively high frequency of gesture in TOT states and, on the other hand, about an increase in TOT states with age. This study aims to unite these disparate bodies of

evidence in order to understand better the relationship between gesture and lexical retrieval.

Method

The study was approved by the City University Ethics Committee. All participants were given written information about the study and given time to read the information sheet and to discuss it with relatives or friends. Participants were also given an opportunity to ask the researchers questions about the study before agreeing to take part, and they were then asked to sign a consent form indicating their assent.

Participants

Two groups participated: 23 younger adults aged 18 - 30 years (Mean = 23, SD = 4.39) , and 22 older adults aged 60 - 75 years (Mean = 68.18, SD = 4.17). . An upper limit of 75 was set to minimize the impact of cognitive decline. Younger participants had a mean of 15.13 years of education (SD = 1.72), were predominantly female (16F, 7M), and were predominantly right-handed (18R, 5L). Similarly the older adults had a mean of 15.77 years of education (SD = 3.82), were predominantly female (15F, 7M), and most were right-handed (20R, 2L). Participants were recruited from universities and community groups. All had English as their first language.

Participants completed a questionnaire to determine if any health-related conditions would interfere with their ability to participate in the study. Upper limb movement difficulties were reported by six older participants. However, all achieved the maximum score of 57 on The Action Research Arm Test (ARAT; Lyle, 1981) indicating minimal difficulties and so they were included in the study. Cognitive status (orientation, immediate recall, short-term memory and attention) was assessed with the Mini-Mental State Examination (Folstein, Folstein, & McHugh, 1975). No participants were excluded due to cognitive decline. Older and younger adults had means of 29.18 (SD= 1.09) and 29.5 (SD= 0.59). Four participants, who reported

hearing or visual impairments, viewed the stimuli/photos to determine whether these impairments would affect their participation. During the training phase, they indicated that they could clearly hear or see the auditory or pictorial stimuli, respectively. No other medical difficulties were reported which required exclusion.

Study Design

The aim was to explore differences between the type and frequency of gestures produced during "tip of the tongue states" by participants in two age groups, using a pseudoword paradigm (Schwartz and Smith, 1997. A set of unusual objects were given both made-up functions and names (pseudowords). Participants were asked to try to learn and then retrieve the pseudowords when shown a picture of the object (naming condition) and to describe a silent video in which an actor used the object (narrative condition). Gestures made by the participants were recorded and analysed.

Stimuli

Twenty objects were collected and described to participants as "tools for making something". They were uncommon household devices (e.g. part of a garlic press) and unusual objects. The objects were given distinct functions designed to trigger iconic gestures related to their shape-outline and function, and these functions were paired with a pseudoword. This ensured that any associations between an object's actual function and a real word would be minimised.

Ten two-syllable and 10 three-syllable pseudowords were created - please see the Appendix for details. Their phonology followed restrictions governing English consonant clusters and CV combinations. They were generated from American English (Frisch, Large, & Pisoni, 2000) and adjusted to fit British English intonation patterns. These changes clearly distinguished middle vowels. No changes were made to consonants. All had primary stress on the initial syllable to aid processing (Vivevitch, Luce, Charles-Luce, & Kemmerer, 1998).

Experimental tasks

Participants carried out two tasks: a naming task and a narrative task. In the former they were shown digital photos of the objects in a PowerPoint presentation and asked to name them. In the narrative task they watched videos of an actor performing tasks with the objects and were asked to describe the activities seen. The same 20 objects appeared in each task.

Procedure

Participants were invited to take part in a project titled "Tip-of-the-tongue" phenomena: word access in younger and older adults. They were told to memorise 20 made-up words for tools. They were not informed that gesture production was of particular interest until they had completed the project. Participants were video-recorded during all phases.

Participants were asked to learn the names of the objects by viewing pictures of them presented on a MacBook. They wore headphones through which they heard the object's names recorded by a native English speaker. The name and the object's function were also written below its picture. Each picture was presented for 15 seconds. Participants saw the objects three times.

Participants then did the naming and narrative tasks. The order of the tasks was counterbalanced across participants.

Naming

The same pictures were presented without the spoken names and with the written pseudoword and function of the object removed and participants were asked to recall the pseudowords. Slides were presented at 60 second intervals. If participants experienced difficulty recalling a pseudoword, they were instructed to provide any information they could about the object.

When difficulties in naming occurred, the experimenter stopped the slide show and gave the first phoneme and vowel pair as a cue. Then, participants were given an extra 60 seconds to retrieve the pseudoword before re-starting the presentation. If a participant indicated that they could still not recall an objects name, an additional

prompt was given- “is there anything else that comes to mind related to the specific object?” The aim was to encourage participants to provide any information they had about the word – either semantic, or a sub-part of the phonology – in order to induce a “tip-of-the tongue” state where a word could not be named.

Narrative Task

Four videos were created to represent a sequence of action-related events. A female actor was shown: a) making a candle, b) making a lemon tart, c) making a leather belt and d) making jewellery. Each video used five of the objects. The actor was told the sequence of the action-related events to be portrayed. Each scene was scripted beforehand to ensure her familiarity with the tools and events. The video recordings were professionally edited onto DVDs. The actor’s face was not visible and the sound was cut so that her body and hand movements were the only source of gestural information.

Participants watched videos and were told they would see “someone using the tools you have seen to make something”. They were told “watch carefully as you will be asked to describe what you see using the made-up words you have learned”. After each video, they described what they had seen. If they omitted some tools used in a video, a prompt was given (e.g. “You have mentioned four tools, there is one missing; can you remember which one?”). Minimal cueing was offered to avoid prompting recall of the phonological forms of the pseudowords of each tool and, therefore, preserve as much as possible, the naturalistic nature of a narrative description.

Coding

TOT states were defined as episodes of hesitant speech which indicated word-finding difficulties (WFD) resembling those for real words. These were characterised by hesitations, efforts to approximate the appropriate word (sometimes repeatedly) and other fillers or circumlocutions. Such episodes were sometimes followed by participants saying they could not remember the name, but not always. Co-TOT gestures were identified as those gestures which accompanied TOT states as defined above. They were coded as either iconic (gestures depicting semantic information about the shape or function of the object via the shape, placement, and/or motion trajectory of the hands) or non-iconic (gestures not relating to the semantic content of the verbal language but instead, for example, marking emphasis or a rhythmic boundary or expressing metalinguistic meaning such as abandoning an attempt to say the pseudoword). Participants often produced more than one for an object, and on these occasions, although gestures formed a whole semantic unit as they were produced in the same semantic context as the pseudoword in search, they were counted and classified (iconic/non-iconic) individually depending on the information they were providing. Completion of a gesture was defined as the point where a participant produced either a phonemic approximation of the pseudoword (unresolved TOT) or the pseudoword following a phonemic cue (resolved TOT) or provided with any semantic information related to the target (e.g. shape or function) like "I cannot remember the name…umm.. well, one of the tools for picking fruits", or presented with a "give-up" behaviour (unresolved TOT). A gesture was also coded if participants experienced WFD behaviour, but made no attempt to retrieve the phonological form of the pseudoword. This "pseudo-TOT state" was observed in both groups, usually in mid-narrative, and was accompanied by non-fluent speech

characterised by pauses, fillers and a verbal indication of a "pseudo-TOT state" like "Umm, I don't have a clue about the word, but there was another tool/instrument used..." Other indications of a "pseudo-TOT state" included long pauses with statements like "Umm…there is one missing tool…this is so frustrating, but I can't remember" or "…what else did she use…" In this word-searching "pseudo-TOT state", participants produced circumlocutions as they were heavily relying on retained semantic representations about the tool, possibly due to the absence of its phonological representation. Semantic representations of the objects were delivered either with the use of generic terms like "she used the thing/object/instrument/piece of equipment" or with a noun phrase like "she used the… [the candle sharpener]". In some occasions gestures preceded speech output. The gestures produced in this "pseudo-TOT" state, were also coded following the same classification as for the co-TOT gestures.

Inter-rater agreement on coding was checked. A second rater watched 10% of the videos and identified and coded all gesture production including both iconic and non-iconic gestures. The percentage of agreement was 96% (K= 0.93) for coding iconic versus non-iconic gesture production and 93% (K=0.87) for identifying the semantic type of iconic gesture (shape-outline, function/attribute – see next section). For the disagreements, gesture classification was discussed and resolved which in all cases resulted in a classification based upon the first researcher's coding.

Data Analysis

Three main analyses were carried out.

1: Frequency of co-TOT gestures

The total number of TOT states with or without gestures was recorded and these were compared across tasks and for younger and older participants. In this analysis the data is the number of occasions (out of 20) that a TOT state occurred. A three factor ANOVA was used to compare the frequency of co-TOT gestures produced by older and younger adults in the naming and narrative tasks. Age (younger/older participants) was a between subjects variable and task (naming/narrative) and response (gesture/no gesture) were within subject variables.

The other analyses looked at the types of gesture that occurred.

2: Iconic and Non-Iconic Gestures

A typical iconic gesture depicted the function of the object. Non-iconic gestures produced during a TOT state were often palm revealing gestures, where the hand orientation is palm up or the hand turns to reveal the palm. These gestures have been found to be typical alongside hesitant dysfluent speech (Bavelas, Chovil, Coates, & Roe, 1995). A further three factor ANOVA was performed to examine whether gestures were iconic or non-iconic. Age (younger/older participants) was again a between subject variable and task (naming/narrative) and type of gesture (iconic/non-iconic) were between subject variables.

3: Iconic Gestures

The third analysis concerned the type of iconic gesture, contrasting shape-outline with function/attribute. This distinction is based on the classification system used by Cocks et al. (2011). In these analyses, the data were the total number of gestures of the different types made by the participants. A three factor ANOVA was used to

determine the type of semantic information conveyed in iconic gestures. The age of the participants (younger/older participants) was again a between subjects variable and task (naming/narrative) and type of gesture (shape-outline vs. function/attribute) were within subject variables.

Gestural behaviour during TOT states was the focus of this research rather than naming abilities per se. However it is possible that differences between the two groups in terms of accuracy may have affected TOT frequency, and so we also scored accuracy in the naming task.

Results

Frequency of co-TOT gestures

As table 1 shows, the total number of TOT states did not differ between younger and older participants (younger M= 28.86, SD = 4.52; older M= 27.82, SD = 6.07). The main effect of response was significant indicating that TOT states lead to gestures in a large majority of cases (72.55%, $F(1, 42) = 58.12$, $p < .001$). The main effect of task showed that less TOT states occurred on the narrative task ($F(1, 42) = 30.17$, $p < .001$).

[insert Table 1 here]

A significant interaction between age and task ($F(1, 42) = 30.92$, $p < .001$) indicated that older adults experienced more TOT states than younger adults on the naming task but less on the narrative task.

The interaction between age and response ($F(1, 42) = 9.45$, $p < .01$) indicated that younger adults generated more gestured responses (81.1% of TOT states were gestured) than the older adults (63.7%) and the three way interaction between age, task and response ($F(1, 42) = 12.17$, $p < .01$) indicated that this was due to the narrative task where the older adults were less likely to gesture.

Iconic and Non-Iconic Gestures

As table 2 shows, the effect of age on gesture type was significant ($F(1, 42) = 5.13$, $p < .05$).

[insert Table 2 here]

The main effect of type of gesture was highly significant ($F(1, 42) = 52.34$, $p < .001$), due to the greater number of iconic gestures. The main effect of task was not significant. The interaction between task and type of gesture was highly significant ($F(1, 42) = 36.89$, $p < .001$). Iconic gestures predominated in both tasks but to a much greater extent in the narrative task where they outnumbered non-iconic gestures by a margin of twelve to one. The interaction of age by task was significant ($F(1, 42) = 26.53$, $p < .001$). As Table 2 shows, younger adults produced more gestures especially in the narrative task, whereas older adults produced more gestures in the naming task. The interaction of age by type of gesture was of borderline significance ($F(1, 42) = 4.08$, $p = .05$). Both groups generated more iconic than non-iconic gestures but the difference was greater for the younger adults. The three-way interaction between age, task and type of gesture was also significant ($F(1, 42) =$

22.76, p < .001). Young adults produce many more gestures and many iconic gestures in the narrative task while older adults gestured more in the naming task.

Iconic Gestures

The main effect of age was significant (F (1, 42) = 5.08, p <.05; see table 3) again showing that younger adults were more likely to gesture. The main effects of task (F = 14.19, p < .01) and type of gesture (F (1, 42) = 74.32, p < .001) were also significant indicating the stronger tendency to gesture during the narrative task and that there were many more function/attribute gestures than shape-outline gestures.

[insert Table 3 here]

A significant interaction between age and task (F (1, 42) = 30.67, p < .001) again showed that younger adults were more likely to gesture in the narrative task and older adults in the naming task. A significant interaction between age and type of gesture (F (1, 42) = 7.12, p = .01) showed that while both groups produced more function/attribute gestures, this was particularly so for the younger group. The interaction between task and type of gesture was also significant (F (1, 42) = 10.58, p < .01). Function/attribute gestures predominated on both tasks, but particularly so on the narrative task. The three-way interaction was also significant (F (1, 42) = 26.13, p < .001). This effect was due to the strong preference of younger adults for function/attribute gestures especially in the narrative task.

Accuracy

A Fisher's exact test, p= 0.4075, indicated no significant difference between groups in accuracy scores on the naming tasks (younger mean = 17.72/20, s.d. = 2.38 ; older mean = 14.54/20, s.d. = 2.05).

Discussion

The current study explored the relationship between gesture and lexical retrieval during TOT states. We compared older and younger adults' use of co-TOT gestures in a narrative and naming task and found both age and task differences. All participants frequently gestured during TOT states but younger adults gestured more than older adults. Iconic gestures were more common than non-iconic gestures and among these, function/attribute gestures were more frequent than shape-outline gestures. Younger and older participants did not differ in the number of TOT states they experienced but the younger participants had more TOT states during the narrative task, while older adults had more during the naming task. Both produced more iconic than non-iconic gestures, particularly in the narrative task where participants saw a video of an actor using the objects. Function/attribute gestures predominated for both groups of participants and in both tasks but particularly so for young adults in the narrative task.

The overall similarity in the number of TOT states produced by both groups is an interesting and new finding. Previous research has suggested that TOTs increase with age, as far as proper name retrieval is concerned, in both spontaneous speech output and under experimental conditions (Burke et al., 1991). In the present study, older participants had fewer TOT states than younger participants in the narrative task, which may have been due to the use of pseudowords as opposed to real words in this study. Given that the pseudowords used in this study were unfamiliar lexical items for pretend tools, the task for learning them would have involved attempting to encode both a new phonological form (lexeme) and a new lexico-semantic representation (lemma). In the narrative and naming tasks therefore the participants were relying on weak representations. The two groups approached this difficulty in

two different ways. The older adults 'circumlocuted', thereby providing sufficient semantic information to identify the target referent without the need to retrieve the pseudoword's phonological form. The younger group, however, frequently exhibited pseudoword-searching behaviour often resulting in the production of an approximation, and accompanied by robust gestural production. The low number of TOT states by the older adults in the narrative task may also reflect the additional memory requirement of the narrative task. Although not directly measured, an increase was observed in the time spent on the narratives for the older group, often accompanied by failures to retrieve all of the action-sequences presented. In other words, the younger group actively attempted to access the pseudoword, whereas, the older adults either were too busy attempting to retrieve the story or avoided the word by 'circumlocuting'.

The older adults also used less iconic gesture in the narrative tasks than the younger adults. Some previous researchers have suggested this is due to either a decreased involvement of visual imagery and/or physical changes (Cohen & Borsoi, 1996; Gullberg et al, 2008), however this cannot be the case in the present study because of the task differences. Older adults used more iconic gestures than the younger adults in the naming task. The differences observed here are therefore more likely to be due to how the older and younger adults approached the tasks rather than any inability to produce gestures. Feyereisen and Havard (1999) examined the co-speech iconic gesture and beats used by 23 younger (M = 21 years) and 19 older adults (M = 70 years) adults. Three discussion topics were used to activate either visual images, motor images, or no mental image (abstract topics). Although the rate of gesture production did not differ between younger and older adults, there was a significant

interaction between age and topic, such that iconic gesture was relatively less frequent in older adults, especially in the visual imagery condition. The authors suggest that this task-specific decrease in iconic gestures in their older adults was due to stylistic language differences between younger and older adults, and they proposed a trade-off between richness of verbal and gestural responses .

In the present study, when faced with difficulty retrieving a word in a narrative, the older adults were less likely to actively search for that word and use iconic gesture alongside that search, instead they circumlocuted. Such behaviour is in line with other findings such as the fact that lexical diversity tends to be higher among older adults than younger adults (e.g. Hupet, Chantraine, & Nef, 1993). Although the pseudo-words were novel in the present study, age-related language changes may have influenced performance, and may explain why the older adults were more likely to circumlocute. Circumlocution was rarely associated with iconic gesture production. Recall that on the narrative task the visual imagery of each object was not enhanced by computer-generated visualisations as it was in the naming task, and so participants would have had to maintain this information in spatial working memory. The data suggest that older participants preferred to linguistically code this stored visual information rather than gesture it, which lends support to Wesp, Hesse and Keutmann's (2001) argument that gestures are not needed to maintain information in spatial working memory as long as it is verbally expressed. However, the older adults' approach was somewhat different in the naming task where they generated more co-TOT gestures than the younger group. As argued above, these gestural differences correspond with stylistic differences between older and younger participants on this task.

In the naming task, where the visual imagery of each object was enhanced by computer-generated visualisations, the older people did not circumlocute as they did in the narrative task but used an approach which involved activating visual imagery. For instance, two participants in the older group did not attempt to recall any of the 20 pseudowords but instead gestured visual-motoric information for each response. When asked about this they said that they realised during the training phase that they would not be able to recall the labels and focused on the "tools' function". The younger adults produced less gesture on this task than on the narrative task, which suggests that the visual presentation of the objects diminished their need to hold information in spatial-working memory (De Ruiter, 1998; Wesp et al., 2001; Morsella & Krauss, 2004). This suggests that different cognitive operations affected the two age groups differently in the two different tasks.

It could be argued that methodological differences between the naming and narrative tasks could have affected the data because the naming task involved item-specific prompting to induce a TOT state whereas the narrative task did not. Potentially, by trying to induce a TOT state the possibility of a gesture is increased in one task but not the other, which may have been the cause of the finding that fewer TOT states occurred on the narrative task. However, it is unclear how this methodological difference could explain the age-related differences here. Recall that although the age groups did not differ in the number of TOT states they experienced, the younger participants had more TOT states during the narrative task while the older participants had more TOT states during the naming task. The possibility therefore remains that

different cognitive operations took place in the two age groups for the two different tasks. A limitation of the methodology used here is that the TOT states related to newly-learned pseudo-words and so represented information that was weakly represented in memory. This may reduce the generalisability of these findings but it allowed for the comparison of gestural behaviour across the two age groups in carefully controlled conditions.

No age-effect was found for the type of iconic gestures produced. A higher frequency of function/attribute than shape-outline gestures was observed for both age groups in both tasks. It could be argued that the written description of each object's function presented during the training phase, in conjunction with the motor acts presented in the videos, had a priming function biasing the participants' gesture to depict functions and attributes. Or it could be that the preference to gesture the function of an object they couldn't name when they were in a TOT state, relates to experiential relationships with objects, or reflects the role of such gesture in the maintenance of a number of semantic representations of an object in memory (Morsella & Krauss, 2004). Equally, function/attribute gestures are more likely than shape outline gestures to be effective communicatively (Rothi, Ochipa & Heilman, 1997). The only previous research, which has examined co-TOT gesture use, has been with people with aphasia (Cocks et al., 2011, 2013). They found a high frequency of "shape outline" gestures during word search behaviors for nouns when describing cartoon animations. The difference in findings between the current study and those of Cocks and colleagues may be because 1) the latter studied participants with aphasia, 2) the stimuli were real words instead of pseudowords, or 3) the stimuli were not all tools.

Whether the use of objects representing a category other than “tools” is likely to trigger a greater or equal amount of shape-outline gestures needs to be investigated in future research.

Conclusion and Future directions

The present study investigated the relationship between gestures and aging in TOT states. For both older and younger adults, iconic gestures, especially those depicting the function and attributes of an object, were more common. Participants in both age groups experienced a similar number of TOT states, although there was a significant task-specific age difference such that younger adults gestured more in the narrative task and older adults gestured more in the naming task. This task difference may have reflected the way the older and younger adults approached the tasks, with older adults circumlocuting around the words they could not say rather much more often that the younger adults.

The present study was an initial attempt to address the gap in the research regarding the presence of age effects in co-TOT gesture production. The findings suggest that the rates of gesture production and the proportion of iconic/non-iconic co-TOT gestures in the two age groups vary when comparing the different experimental conditions as well as individual participants. Further research reporting age-comparative data under different methodologies is needed in order to challenge their viability and establish more global age-related patterns in co-TOT gesturing.

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Appendix

Table 1. List of the twenty (20) pseudowords used in both tasks

No	Pseudowords	
1.	ˈzʊθɛdəəs	(/zoothedous/)
2.	hɛnəət	(/henet/)
3.	ˈgɔfædəəs	(/goarfadous/)
4.	ˈvɔθəəʃ	(/voarthesh/)
5.	ˈkinəəp	(/keenup/)
6.	ˈvɔwəəθɛd	(/voarwethead/)
7.	ˈmirəənəəm	(/meerenum/)
8.	ˈsæʃəm	(/sashem/)
9.	ˈmænəən	(/manen/)
10.	ˈsitɪdəən	(/seetiden/)
11.	ˈzuθɛd	(/zouthed/)
12.	ˈmidəət	(/meedet/)
13.	ˈvʊðəəʃ	(/voothesh/)
14.	ˈzʊfɛdəəʃ	(/zoofedash/)
15.	ˈgufəəgəd	(/goufagud/)
16.	ˈhæsəələəp	(/haselup/)
17.	ˈgʊðəəs	(/gouthous/)
18.	ˈhɛsəələəm	(/heselum/)
19.	ˈkɪtəədəəp	(/keetedup/)
20.	ˈguʒəəd	(/goused/)

Table 2. Narrative Task - Scenarios

Narratives	**Objects/Tools used**
1. Making a **candle**	1. (/ˈ**zuθɛd**/): for poking holes
	2. (/ˈgɔ**fædəəs**/): for sharpening the candle
	3. (/ˈ**mænəən**/): for trimming the wick
	4. (/ˈ**vɔθəə**ʃ/): for holding the wick stable
	5. (/ˈ**hɛsəələəm**/): for lifting candles out of candlesticks
2. Making a **lemon tart**	1. (/ˈ**hæsəələəp**/): for picking fruits off the tree
	2. (/ˈ**vɔwəəθɛd**/): for pressing lemon when cooking
	3. (/ˈ**midəət**/): for getting fine bits of lemon juice out
	4. (/ˈ**zʊθɛdəəs**/): for pouring sugar
	5. (/ˈ**sæ**ʃ**əm**/)**:** for mixing sugar & lemon juice
	6. (/ˈg**uʒəəd**/): for grabbing bakery tray from the oven

Table 2. Narrative Task - Scenarios

Narratives	**Objects/ Tools used**
3. Making a **leather belt**	1. (/ˈ**h**ɛ**nəət**/): for straightening the leather
	2. (/ˈ**k**ɪ**təədəəp**/): for taking the fur off the leather
	3. (/ˈ**sit**ɪ**dəən**/): for drilling holes in leather
	4. (/ˈ**z**ʊ**f**ɛ**dəə**ʃ/): for removing thin strips of leather from a belt
	5. (/ˈg**uðəəs**/): for smoothing belt edges
4. Making **jewellery**	1. (/ˈ**v**ʊ**ðəə**ʃ/): for making patterns on metal
	2. (/ˈ**kinəəp**/): for holding things apart when making jewellery
	3. (/ˈ**mirəənəəm**/): for forming ring shapes
	4. (/ˈg**ufəə**gə**d/**): for cleaning the jewellery

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Tables

TABLE 1

Number of TOT states with and without gesture for younger and older adults in the naming and narrative tasks

		Naming		Narrative	
		Gesture	No gesture	Gesture	No gesture
Younger	Mean	10.36	4.05	13.05	1.41
	SD	4.51	3.05	3.13	2.08
Older	Mean	11.55	6.05	6.18	4.05
	SD	5.09	4.60	3.99	3.64

TABLE 2

Number of iconic and non-iconic gestures for younger and older adults in the naming and narrative tasks

		Naming		Narrative	
		Iconic	Non-iconic	Iconic	Non-iconic
Younger	Mean	9.54	7.50	27.23	2.09
	SD	8.45	7.12	15.91	2.86
Older	Mean	13.45	7.18	9.86	0.81
	SD	12.04	6.52	7.72	1.96

TABLE 3

Number of shape-outline and function/attribute gestures for younger and older adults in the naming and narrative tasks

		Naming		Narrative	
		Shape-outline	Function/ Attribute	Shape-outline	Function/ Attribute
Younger	Mean	2.09	7.45	5.00	22.23
	SD	2.54	6.21	3.92	13.77
Older	Mean	3.09	10.36	2.72	7.36
	SD	3.86	9.70	2.60	5.89