The effects of prohibiting gestures on children's lexical retrieval ability

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Abstract

Two alternative accounts have been proposed to explain the role of gestures in thinking and speaking. The Information Packaging Hypothesis (Kita, 2000) claims that gestures are important for the conceptual packaging of information before it is coded into a linguistic form for speech. The Lexical Retrieval Hypothesis (Rauscher et al., 1996) sees gestures as functioning more at the level of speech production in helping the speaker to find the right words. The latter hypothesis has not been fully explored with children. In this study children were given a naming task under conditions that allowed and restricted gestures. Children named more words correctly and resolved more 'tip-of-the-tongue' states when allowed to gesture than when not, suggesting that gestures facilitate access to the lexicon in children and are important for speech production as well as conceptualization.

The effects of prohibiting gestures on children's ability to retrieve words

Like adults, children frequently gesture with their hands when they speak. The question about why gestures are so ubiquitous, even in the absence of a listener (people gesture, for example, when speaking on the telephone) has prompted theorists to debate their function. This paper addresses the issue of how gesturing helps the speaker, particularly the young child.

The Information Packaging Hypothesis (Kita, 2000) suggests that gestures facilitate the conceptual packaging of information before it is coded into a linguistic form for speech. On the other hand there is a view that gestures function more at the level of producing the surface utterance, by helping the speaker retrieve the right word: the Lexical Retrieval Hypothesis (Rauscher , Krauss & Chen, 1996). Thus, where the Information Packaging Hypothesis implicates gesture in *thinking*, the Lexical Retrieval Hypothesis implicates gesture in *speaking.*

Children have been found to produce hand gestures when asked to describe problems from a range of different domains. These gestures provide researchers with privileged access into the mind of the child; access to information that is not present in the child's speech. Iconic gestures convey semantic information relevant to the simultaneously expressed linguistic meaning (McNeil, 1992) and are particularly revealing because they can reflect the content of the child's thought.

For example, when studying children's understanding of the conservation of liquid task children's gestures have been reliably coded according to which task variable they convey, e.g. the *width* of the container, or the *height* of the liquid (Church & Goldin-

Meadow, 1986). Such iconicity has also been identified in the domains of mathematics (Alibali & Goldin-Meadow, 1993) and balance (Pine, Lufkin & Messer, 2004) suggesting that children produce iconic gestures when talking about abstract ideas as well as ones with a concrete and spatial component. These findings have produced considerable support for the Information Packaging Hypothesis, since the children's gestures appeared to be integral to their thinking processes as they acquire concepts in a variety of domains.

However, we only have to look around us to see that gestures are inextricably linked to speaking. People rarely gesture when they are not talking and can be observed to gesture more when trying to access a word that is on the 'tip of the tongue'. According to the Lexical Retrieval Hypothesis (Rauscher et al, 1996) gestures facilitate the retrieval of items from the mental lexicon. Rauscher et al reason that if gesture facilitates lexical access, then restricting gesture should increase the difficulty of lexical access. They indeed found that, in adults, the effects of restricting gesture paralleled those of artificially increasing the difficulty of lexical access by placing constraints on speech.

In a study to try to compare these two alternative accounts of gesture (conceptual or lexical) in children Alibali, Kita & Young (2000) used a conservation task and asked children either to *explain* the task or *describe* it. Their rationale was that explaining would make *conceptual* demands whereas description would only tax the *lexical* system. The similarity between the task features was expected to give rise to comparable speech content (thus controlling for lexical access) but describing or explaining would make different demands on the conceptual packaging of information. Any differences in gesture across these two tasks, they hypothesized, would provide evidence against the Lexical Retrieval Hypothesis. They found children produced more gestures in the

explanation task than in the description task, and concluded that gestures are primarily involved in the conceptual planning of utterances. However Alibali et al do not rule out the possibility that gesture may also facilitate lexical retrieval, but make the point that this is not the main function of gesture.

There is a lack of empirical data in the literature that specifically explores the Lexical Retrieval Hypothesis in relation to *children's* gestures. Many of the tasks that have supported the role of children's gesture in conceptualization are problem-solving tasks with a strong spatial component and could be argued to be more conceptual than lexical. There are no studies to date that have tested children with a task that places less demand on the conceptual system and more demand on the lexicon. Only by doing so can we really begin to understand the role of gestures in lexical access as well as in conceptualization. Therefore, in this study, we give children a picture-naming task and compare their lexical access when allowed to gesture and when prevented from gesturing. If gestures facilitate lexical access, preventing children from gesturing should make lexical access more difficult. If gestures are facilitative it will also be useful to identify the types of gestures that play a significant role in lexical access.

A paradigm that manipulates the difficulty of lexical access involves eliciting tip-of-the-tongue (ToT) states in participants. A ToT state is the experience of *'being sure that the information is in memory but … temporarily unable to access it'* (Brown, 1991, p. 204). A typical method of inducing ToT states in adults involves presenting participants with definitions of words and asking them to produce the word. The adult literature contains conflicting findings regarding the function of gesture, with evidence both for and against a lexical access role. Frick-Horbury & Guttentag (1998) found that

restricting adults from gesturing as they performed a ToT task resulted in significantly poorer performance. However, Beattie & Coughlan (1999) found that while restricting adults from gesturing caused them to resolve fewer ToT states, they paradoxically had a more fluent retrieval process as they recalled more words without entering into a ToT state.

The aim of this study is to test the lexical retrieval hypothesis in children. By comparing children's lexical access ability under conditions that allow or restrict gesture we aim to show that, whilst gestures are important for children's thinking, they also facilitate speech by helping them access the right word and resolve tip-of-the-tongue states.

Method

Participants

Sixty-five children from two Hertfordshire schools took part; 33 boys and 32 girls, aged 6 (n = 33), 7 (n = 23) and 8 years (n = 9) with a mean age of 6,63 years (sd = 0.72).

Materials

Initially 100 words were selected as stimuli and piloted on a sample of ten children in the same age range from a neighbouring school. All words had an age of acquisition between three years and seven years. They also had relatively low word frequency and high imageability ratings so as to increase the likelihood of inducing a ToT state (Bird, Franklin & Howard, 2001; Carroll & White, 1973a; Carroll & White, 1973b; Gilhooly & Logie, 1980). The 50 pictures that induced the most ToT states in the pilot study were then selected as stimuli for this study (Appendix A). The stimuli were split randomly into

two sets of 25 and computer generated black and white line drawings were produced, 100mm x 80mm.

In the experimental condition, children were prevented from gesturing by placing their hands in mittens with Velcro fixed to the palm. They were asked to place their hands, palms down, onto a board on the table in front of them with Velcro strips to secure the mittens.

Procedure

All children completed the task under the *gesture allowed* condition and the *gesture prohibited* condition, with 25 pictures per condition, counterbalanced. In the *gesture prohibited* condition the child was asked to place their hands in to the mittens and stick them on to the board in front of them. The *gesture allowed* condition had no further instructions. Children were shown one picture at a time and asked to name each picture. Once the picture had been identified the experimenter continued to the next picture until all 25 pictures had been presented. If the child had not named the picture in 15 seconds a probe was given from a list of standardised prompts (see Appendix B). Probes were used to establish that the child had attempted to identify each item, thus ensuring that all ToT states were identified. If, after probes were given, the child was still not successful in identifying the picture, or stopped guessing and said they didn't know what it was, then the experimenter identified the picture and moved on to the next one.

Coding Gesture.

The gestures that children produced while performing the task were coded according to categories defined by Beattie & Coughlan (1999) and McNeill (1985). A gesture was identified from the point where the child's hands left an equilibrium position

where the hands were still, and was broadly defined as any hand, finger or arm movement. The gesture was identified to have ended when the child's hands returned to an equilibrium position. These movements were divided into three specific gesture groups;

Iconic Gestures: 'An iconic gesture is one that in form and manner of execution exhibits a meaning relevant to the simultaneously expressed linguistic meaning' (McNeill, 1985, p.354). For example if the target word is 'roundabout', the child might perform a rotating action with their hands.

Beats: A beat is a 'simple and rapid hand movement' (McNeill, 1985, p.354), '...typically small simple movements that are performed more rapidly at or near the rest position of the hands' (McNeill, 1985, p.359). For example a child might tap their fingers on the table.

Self-Adaptors: 'Self-adaptors are simple self-touching movements' (Beattie & Coughlan, 1999, p.43). Examples of self-adaptors may include head scratching, hair twirling or face rubbing.

Inter-rater reliability for gesture type was established by having a second rater for fifty of the trials in the gestures allowed condition. Inter-rater reliability for all three types of gesture was high ($k = 0.84$).

Results

Does gesture prohibition affect children's ability to name the pictures correctly?

The number of pictures the children named correctly under both *gesture allowed* and *gesture prohibited* conditions was compared and analyzed.

The mean number of pictures named correctly when children were *allowed* to gesture was 21.49 (sd = 3.07) out of 25. The mean number of pictures named correctly when children were *prohibited* from gesturing was 20.00 (sd = 3.79); a significant difference t (64) = 3.43, p = < .01. Therefore, children correctly named more pictures when free to gesture than when prohibited from gesturing. Next we looked at the instances when children had difficulty naming a picture and experienced a ToT state.

Do children encounter more ToT states when prohibited from gesturing?

Definition of a ToT state

A child was coded as being in a ToT state when it was apparent that they knew the word but had difficulty retrieving it. A number of indicators accompanied a ToT state, including comments such as '*I knew the word but I couldn't take it out*' or '*Oh! I forgot what they're called*'. Children would also become more animate, for example by wincing, rocking in their chair, or throwing their heads into their hands.

Since children's behaviours when they were in a ToT state were overt they were easily distinguishable from states where the child simply did not know the name of the object. On these occasions children were likely to say 'I don't know' without any of the accompanying behaviours described above that indicated they were having difficulty accessing the word. A second rater assessed ToT states and inter rater reliability was high (agreement on > 95% of instances).

ToT states encountered when naming a picture

Overall the mean number of ToT states the children experienced, out of 50 items, was 11.15 (sd = 5.32). When children were allowed to gesture they experienced a mean of 5.68 (sd = 3.37) ToT states (out of 25 words), and when children were prohibited from

gesturing they experienced a mean of 5.48 (sd = 2.92) ToT states. A paired t-test found that the difference in the mean number of ToT states encountered in the two conditions was not significant, (t (64) = 0.474, p = > 0.05).

Next we looked at whether the children successfully retrieved the target word or not after being in a ToT state and how the two conditions affected this ability.

Do children find it harder to resolve a ToT state when prohibited from gesturing?

To assess this, the mean number of ToT states the children resolved in both conditions was analysed. ToT states were classified as *resolved* if, following a ToT state, the child named the picture correctly and *unresolved* if the child failed to produce the target word[1]. The resolved ToT states were then calculated as a proportion of each child's total ToT states.

When allowed to gesture, children resolved their ToT state on 75% of occasions, i.e. a mean of 4.09 (sd = 2.58) ToT states were resolved and a mean of 1.58 (sd =1.55) ToT states were unresolved (25%). In contrast, when the children were prohibited from gesturing, they resolved only 46% of their ToT states; a mean of 2.52 (sd = 1.95) resolved compared with 2.95 (sd = 2.26) unresolved (54%). A paired t-test found that children were significantly more likely to *resolve* their ToT states when *allowed* to gesture than when *prohibited* from gesturing, (t (64) = -4.58, p = <. 001). Therefore, the finding that children correctly name more items when allowed to gesture than when

[1] It should be noted however that children may have encountered TOT states for incorrect words, i.e. we can never be certain that the word the child was apparently searching for was the correct one. In such an instance, the child may have resolved their TOT state as they have produced the word that they were looking for, but their TOT state would have been classified as unresolved because the required word was not produced.

restricted from gesturing, can be explained by the fact that gesture facilitates the resolution of ToT states. However, we went on to assess the amount of speech produced by children in resolved and unresolved ToT states to make sure that this facilitative effect was not merely due to children talking more in resolved ToT states than in unresolved ToT states.

A comparison was conducted between the amount of time spent talking in resolved and unresolved ToT states. In order to take account of individual differences in the amount of speech produced by children, one resolved and one unresolved ToT state from each child's session was sampled and a between-subjects comparison conducted of the amount of time children spent talking in these ToT states. Only children who encountered both a resolved and an unresolved ToT state were included in the sample and the first resolved and unresolved ToT states in each child's session was coded. This yielded a total of 51 resolved and 51 unresolved ToT states for comparison. It was then possible to calculate, using a computer based coding system, the amount of time (in seconds) that children spent talking whilst in each state.

Children spoke for a mean duration of 3.63 seconds (SD = 2.72) in resolved ToT states compared to a mean duration of 4.55 (SD = 4.03) seconds in unresolved ToT states. This difference was not statistically significant, $t(50) = -1.40$, $p > .05$. Since children did not speak more in resolved, than unresolved, ToT states this suggests it was gesture that facilitated resolution rather than speech production.

Analysis of children's gestures in the gesture allowed condition

Type of gesture preceding word retrieval

Next we took a closer look at the *type* of gestures that children produced before naming a picture in the *gesture allowed* condition. This ignores ToT states for the moment and focuses on picture-naming accuracy. To explore how gesture helped word retrieval we analysed the type of gestures that accompanied correct and incorrect responses.

(Insert Figure 1 about here)

Prior to the identification of a correct word, children produced a mean number of 1.05 (sd = 1.51) *iconic gestures*, 1.55 (sd = 1.85) *beat gestures* and 2.49 (sd = 2.53) *self-adaptor gestures*. Before the identification of an incorrect word, children produced a mean number of 0.28 (sd = 0.72) *iconic gestures*, 0.69 (sd = 1.12) *beat gestures* and 1.22 (sd = 1.62) *self-adaptor gestures*.

The mean number of gestures produced prior to the production of a correct word or an incorrect word was compared using paired t-tests. For each type of gesture, the mean number produced was higher before a correct than an incorrect response: *iconic gestures* ($t(64) = 4.54$, $p = < 0.001$); *beat gestures* ($t(64)=3.61$, $p = < 0.001$); and *self-adaptor gestures* ($t(64)=4.38$, $p = < 0.001$).

The difference in gesture production in ToT states and non-ToT states.

The frequency of gesturing in ToT and non-ToT states was compared when children were in the *gesture allowed* condition. The mean number of ToT states that occurred with gesturing was 3.84 (sd = 2.95) and the mean number of ToT states that occurred without gesturing was 1.81 (sd = 2.09). Overall, children gestured more than twice as much during a ToT state compared to a non-ToT state and this difference was reliably significant when compared using a paired t-test ($t(64) = 4.27$, $p = < 0.001$).

Gesture type and ToT states

A closer look was then taken at the frequency with which different types of gesture were produced in ToT states and non-ToT states. A mean of 0.79 (sd = 1.27) iconic gestures were produced in ToT states and a mean of 0.47 (sd = 1.03) were produced in non-ToT states. A paired t-test found this difference to be reliable, t (64) = 1.89, p = < 0.05.

Similar comparisons were carried out for the mean number of *beat gestures* produced in ToT states (M = 1.26, sd = 1.64) or non-ToT states (M = 0.91, sd = 1.22) but this difference was not found to be reliable (t (64) =1.65, p = > 0.05). There was also no significant difference in the mean number of *self-adaptors* produced in ToT states (M = 1.80, sd= 1.83) compared to non-ToT states (M= 1.83, sd = 2.49) (t (64) = -0.93, p = > 0.05)

Gesture and Resolved ToT states

In the *gesture allowed* condition, children gestured with a mean number of 2.74 (sd = 0.28) resolved ToT states and with a mean number of 1.33 (sd = 0.25) unresolved ToT states. This difference was significant (t (64) = 4.23, p = < 0.001). Gesture production was reliably greater in instances when ToT states were resolved than when unresolved, suggesting that gesturing facilitated lexical retrieval.

A closer look was then taken at the production of each type of gesture in resolved ToT states compared to unresolved ToT states. A summary of the means is presented in Table 1.

(Insert Table 1 about here)

All types of gesture were significantly more frequent in resolved ToT states than unresolved TOT states: *iconic gestures* (t (64) = 2.42, p = < 0.05); *beats* (t (64) = 2.85, p = < 0.05) and s*elf-adaptors* (t (64) = 2.37, p = < 0.05).

Therefore, to summarize the findings:

Picture naming:

- Reliably more gestures were produced with a correct than an incorrect response.
- More iconic, beat and self adaptor gestures were produced with a correct rather than an incorrect response

Encountering ToT states

- More gestures were produced with a ToT than a non-ToT state
- More iconic gestures were produced with ToT than with non-ToT states
- There were no differences in the number of beat or self adaptor gestures produced with ToT and non-ToT states

Resolving ToT states

- More gestures were produced with resolved than unresolved ToT states
- This was the case for all types of gesture (iconic, beats and self adaptors).

Discussion

This study was motivated by two alternative accounts of the function of gestures. More specifically, the aim was to assess whether gestures fulfill a lexical access function for children. The Lexical Retrieval Hypothesis (Rauscher et al, 1996; Krauss et al, 1996) states that gestures facilitate access to words in the mental lexicon and therefore will be

useful when lexical access is difficult whilst speaking. This is in contrast to the Information Packaging Hypothesis (Kita, 2000), which argues that gestures function at an earlier stage, to package information into units suitable for verbalization. Studies to date, with children, have found support for the latter hypothesis yet there is a clear lack of empirical data for the former. The two accounts are not, of course, necessarily competing or mutually exclusive. However, it is not clear whether gestures help children not just to package information for verbalization but also to retrieve words from the lexicon. This study set out to address this by giving children a lexical naming task, likely to elicit ToT states, under conditions that either allowed or prohibited gesture. We discuss here the facilitative effects that were found for gesture and the possible mechanisms underlying these.

It was found that when children were prohibited from gesturing lexical access was more difficult for them - they named fewer pictures correctly than when they were allowed to gesture - suggesting that their lexical access was better under gesturing conditions. We looked closely at those moments when children were clearly having difficulty with lexical access, i.e. when they were in a ToT state. The frequency of *experiencing* a ToT state did not differ according to whether or not the children were allowed to gesture. However, when we looked at whether or not the children *resolved* their ToT state, i.e., whether they successfully retrieved the sought-after word, they were more likely to do so under gesturing than not gesturing conditions. This is suggestive of the fact that gesturing facilitates lexical retrieval in children, although an alternative explanation might be that children verbalized more during ToT states and this could facilitate resolution. However, no significant differences were found in the amount of

speech produced in resolved and unresolved ToT states, thus strengthening the argument for the facilitative effect of gesture.

We next consider the mechanisms by which gesturing may assist lexical access. One suggestion (Ravizza, 2003) is that any motor movement can help retrieve items by activating the linguistic system via the motor system. Ravizza used a ToT paradigm to illustrate that producing meaningless movements, such as tapping, resulted in significantly higher resolution rates than remaining immobile. However, this study was conducted with adults and we are cautious about extrapolating these findings to children. Nonetheless teachers do frequently tell children to keep absolutely still whilst talking, or even to sit on their hands. If moving alone is helpful such well-intentioned advice may produce the opposite effect to that intended.

Goldin-Meadow (2003) offers an alternative explanation of the mechanisms by which gesture helps the speaker, suggesting that 'gesturing reduces demands on a speaker's cognitive resources, thereby freeing cognitive capacity to perform other tasks' (p.150). Cognitive load, rather than lexical retrieval, could explain the association of gesture with picture naming, i.e., children gesture when they are running into retrieval difficulties, freeing up cognitive resources necessary for lexical access. However we argue that gesture directly facilitates lexical access by conveying the target word in a visuo-spatial format rather than a verbal format thus exploiting another route to the phonological lexicon, and in this way reduces the speaker's cognitive effort.

A special emphasis in the literature has been placed on the role not just of moving but of producing iconic gestures for speaking and thinking (Rivazza, 2003). We therefore took a closer look at the type of gesture that children produced when in the *gesture*

allowed condition. Iconic gestures were associated with lexical search. They were produced more often when a child was in a ToT state than in a non-ToT state. This would suggest that it is this type of gesture, which relates in form to the content of the lexical affiliate that will be produced under conditions of difficult lexical access rather than any meaningless movement. One explanation for this is that iconic gestures maintain the link between the word and the stored image of it (de Ruiter, 2000). An example of this from our study is when some children were found to produce a rotating movement with the hand when trying to locate the word 'whisk'. Children also were seen producing an arc-shaped hand movement for 'bridge', or a rolling motion for 'rolling pin'. These movements began in the seconds before the utterance of the correct word. According to Krauss et al (1996) these gestures help to maintain the activation of certain spatio-dynamic features while the lexical affiliate is being retrieved. Thus our data support the notion that iconic gestures are important in this process, since they were more likely to be produced in ToT than in non-ToT states. There is some congruence emerging from the findings. The adults in Beattie & Coughlan's (1999) study also resolved fewer ToT states when prohibited from gesturing than when allowed to gesture. Conversely, however, they encountered fewer ToT states when restricted from gesturing whereas the children we studied encountered more. This may be explained by the fact that we piloted the stimuli for our study and selected words that were most likely to produce ToT states. A further difference, however, may be accounted for by their use of definitions. We chose to use pictures to make the task more appropriate for children but this did limit the target words to those that were concrete and imagistic.

In summary, this study provides evidence for gestures having a lexical retrieval function for children. Being prohibited from gesturing had disadvantageous effects on children's ability to name pictures and to retrieve the names of words they were searching for when in a ToT state. This finding extends current knowledge about the role of gestures for children by implicating them not only in conceptualisation but also in speech production. This underlines the importance of gesturing for children. Clearly gestures are facilitative from pre-verbal thinking through to the generation of the utterance, i.e., throughout all stages from thinking to speech production.

References

Alibali, M. W., Goldin-Meadow, S. (1993). Transitions in concept acquisition: Using the hand to read the mind. *Psychological Review, 100* (2), 279-297.

Alibali, M. W., Kita, S., & Young, A. J. (2000). Gesture and the process of speech production: We think, therefore we gesture. *Language and Cognitive Processes, 15* (6), 593-613.

Beattie, G., & Coughlan, J. (1999). An experimental investigation of the role of iconic gestures in lexical access using the tip-of-the tongue phenomenon. *British Journal of Psychology, 90* (1), 35-56.

Bird, H., Franklin, S., & Howard, D. (2001). Age of acquisition and imageability ratings for a large set of words, including verbs and function words. *Behaviour Research Methods, Instruments & Computers, 33*(1), 73-79.

Brown, A. S. (1991). A review of the tip-of-the-tongue experience. *Psychological Bulletin, 109,* 204-223.

Carroll, J. B., & White, M. N. (1973a). Age-of-acquisition norms for 220 picturable nouns. *Journal of Verbal Learning and Verbal Behaviour, 12,* 563-576.

Carroll, J. B., & White, M.N. (1973b). Word frequency and age-of-acquisition as determiners of picture-naming latency. *Quarterly Journal of Experimental Psychology, 25,* 85-95.

Church, R. B. & Goldin-Meadow, S., (1986). The mismatch between gesture and speech as an index of transitional knowledge. *Cognition, 23,* 43-71.

de Ruiter, J. P. (2000). The production of gesture and speech. In D. McNeill (Ed.), *Language and Gesture* (pp. 284-311). Cambridge: Cambridge University Press.

Frick-Horbury, D.& Guttentag, R.E. (1998). The effects of restricting hand gesture production on lexical retrieval and free recall. *American Journal of Psychology, 111,* 44-61.

Gilhooly, K. J., & Logie, R.H. (1980). Age-of-acquisition, imagery, concreteness, familiarity and ambiguity measures for 1,944 words. *Behaviour Research Methods, Instruments & Computers, 12* (4), 395-427.

Kita, S. O. A. (2000). How representational gestures help speaking. In D.McNeill (Ed.), *Language and gesture*. Cambridge: Cambridge University press.

Krauss, R. M., Chen, Y., & Chawla, P. (1996). Nonverbal behavior and nonverbal communication: What do conversational hand gestures tell us? In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 28, pp. 389-450). San Diego: Academic press.

McNeill, D. (1985). So you think gestures are nonverbal? *Psychological Review, 92* (3), 350-371.

McNeill, D. (1992). Experiment on gestures of the concrete. In D. McNeill (Ed.), *Hand and mind: What gestures reveal about thought:* Chicago, IL, US: University of Chicago Press.

Pine, K. J., Lufkin, N., & Messer, D. J. (in press). A microgenetic analysis of the relationship between speech and gesture in children: Evidence for semantic and temporal asynchrony. *Language and Cognitive Processes*

Pine, K. J., Lufkin, N., & Messer, D. (2004). More gestures than answers: Children learning about balance. *Developmental Psychology, 40* (6), 1059-1067.

Rauscher, F. H., Krauss, R.M. & Chen, Y. (1996). Gesture, speech and lexical access. *Psychological Science, 7* (4), 226 - 230.

Ravizza, S. (2003). Movement and lexical access: Do non-iconic gestures aid in retrieval? *Psychonomic Bulletin and Review,* 10(3), 610-615.

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Figure 1: The mean number of types of gestures produced preceding correct and incorrect picture-naming attempts.

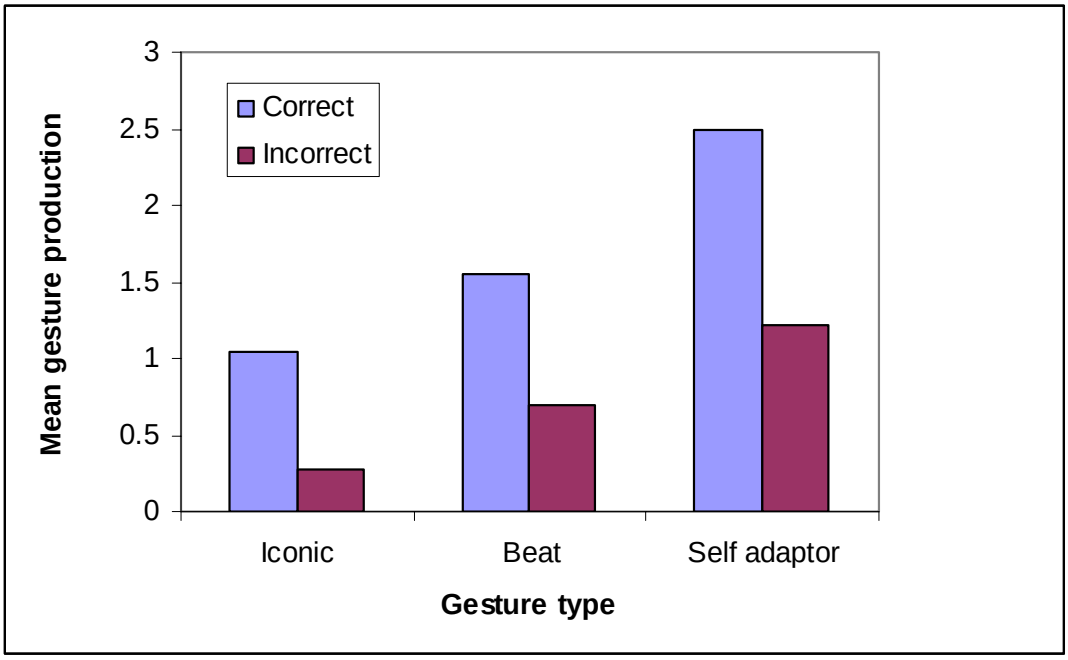

Table 1: Mean number (and sd) of all types of gesture produced in resolved and unresolved ToT states

	Iconic		Beat		Self-adaptor		Total gesture	
ToT State:	Mean	sd.	Mean	sd	Mean	sd.	Mean	sd
Resolved	0.65	1.00	0.91	1.38	1.19	1.32	2.74	0.28
Unresolved	0.20	0.51	0.37	0.84	0.77	1.11	1.33	0.25

APPENDIX A: List of stimuli used in the picture-naming task

Umbrella
Saddle
Beehive
Zebra
Feather
Kangaroo
Astronaut
Hot Air Balloon
Sea Horse
Traffic Light
Bow and Arrow
Cone
Camel
Mermaid
Saw
Shower
Hedgehog
Broom
Anchor
Lobster
Big Ben
Tiger
Palm tree
Maze
Igloo
Scarecrow
Cactus
Fire extinguisher
Flamingo
Pineapple
Pyramid
Koala
Octopus
Palette
Juggling
Parachute
Saxophone
Safety Pin
Bridge
Submarine
Apron
Bagpipe
Thermometer
Watering Can
Iron
Binoculars
Rolling Pin
Door Handle
Stethoscope
Whisk

APPENDIX B: Standardised Prompts used on the picture naming task

Presented to the participant after a period of 15 seconds, or if the participant informs the experimenter that they cannot identify the picture.

Child response: "...Don't know..." or struggling:
Motivate required: "do you think if I gave you a little bit longer you might know it?"

Child response: (continued struggling.)
Probe required: "Can you describes the picture to me?" " What can you see?"

Child response: (description with no answer)
Probe required: "And what do you think that might be?"
"What do you think has those things you have just said/one of those is called"

Child response: "...I think I know it."..(ToT state)
Probe required: "If I told you the word began with a '__' would that help?"