# Giving cognition a helping hand: The effect of congruent gestures on object name retrieval

*Running head*: Congruent gestures and object name retrieval

*Keywords:* Gestures; Congruency effects; Embodied cognition; Action-cognition links

## Abstract

The gestures that accompany speech are more than just arbitrary hand movements or communicative devices. They are simulated actions that can both prime and facilitate speech and cognition. This study measured participants' reaction times for naming degraded images of objects when simultaneously adopting a gesture that was either congruent with the target object, incongruent with it, and when not making any hand gesture. A within-subjects design was used, with participants ($N$ = 122) naming ten objects under each condition. Participants named the objects significantly faster when adopting a congruent gesture than when not gesturing at all. Adopting an incongruent gesture resulted in significantly slower naming times. The findings are discussed in the context of the intrapersonal cognitive and facilitatory effects of gestures and underline the relatedness between language, action, and cognition.

**Giving cognition a helping hand: The effect of congruent gestures on object name retrieval**

Actions are often viewed as derived from a goal state, the consequence of a sequential process that begins with perception and, via cognition, ends with physical movement (Pylyshyn, 1999). An alternative notion is that cognitive processes are embedded in the interaction between the physical body and its external environment. Prinz (1997), for example, views action, perception and cognition as inter-related processes, influencing each other in complex and complimentary ways that are not predicated on any sequential order. Theories of embodied cognition view thinking as grounded in, and inseparable from, physical action. In this study we explore the action-cognition link by looking at how hand actions can enhance perception, when the physical stance adopted is congruent with a to-be-perceived object. This investigation is based on the premise that gestures are simulated actions that can both prime and facilitate perception, cognition and speech.

The gestures that accompany speech are usually spontaneous and involuntary. Psychologists have long debated the specific purpose of speech-accompanying gestures, and whether their role is interpersonal or intrapersonal. The gestural communication hypothesis affords gestures little cognitive purpose, viewing them as purely communicative and serving primarily an *interpersonal* function. This argument is based on studies that find greater effectiveness of communicating a message with gestures than without (e.g. Beattie & Shovelton, 1999; Kendon, 1980) and those which have found a higher rate of gesturing when speakers are face-to-face, compared to when the listener is out of sight (Alibali, Heath, & Myers, 2001; Krauss, Chen, & Gottesman, 2001). Gestures that accompany speech provide listeners with accessible, and sometimes additional, semantic information that is relevant to language comprehension (Alibali, Flevares, & Goldin-Meadow, 1997; Kendon, 1987; Singer & Goldin-Meadow, 2005).

However, listeners have no difficulty comprehending speech that is delivered without gestures. Furthermore, speakers still gesture when the visible communication demands are removed, or when the speaker cannot see the speaker's hands (Rime, 1982; de Ruiter, 2000). Studies that manipulate listener visibility find that gestures do not disappear when the partner is out of sight; they simply reduce in frequency (Cohen, 1977; Jacobs & Garnham, 2007; Pine, Gurney, & Fletcher, 2010). The persistence of gesture production in the absence of an addressee may be attributable to the inability to suppress communicative gestures that occur automatically with speech. An alternative explanation is that gestures persist because they are useful for the speaker, and perform an *intrapersonal* function. Rather than being derived from any goal state, they are integrally linked to a range of cognitive processes including perception, language, memory, and problem solving. Pine et al. (2010) adopt this position, and their *semantic specificity hypothesis* identifies the types of iconic gestures that speakers continue to produce when the listener is not visible.

Recent debates about the specific role that gestures play for the speaker have focused on two approaches, assigning gesture either a cognitive or lexical role. The Information Packaging Hypothesis (Kita, 2000) proposes that gestures are involved in the conceptual planning phase of speaking. Building on McNeill's (1992) theoretical position that "gestures, together with language, help constitute thought" (p. 245), gestures are proposed to play a role in the construction of the pre-verbal message. Consistent with this view is evidence that gestures convey conceptual information that is not present in speech (Goldin-Meadow, 1999; Pine, Bird, & Kirk, 2007); gestures signal a transitional state when the speaker is open to instruction, particularly with children (Church & Goldin-Meadow, 1986; Goldin-Meadow, Alibali, & Church, 1993;

Pine, Lufkin, & Messer, 2004); gesture production increases with greater conceptual demands (Alibali, Kita, & Young, 2000; Hostetter, Alibali, & Kita, 2006; Thurnham & Pine, 2006), and gesturing can reduce the speaker's cognitive load (Goldin-Meadow, 2000).

An alternative approach links gestures more with speech production than with thinking-for-speaking. The Lexical Retrieval Hypothesis (Rauscher, Krauss, & Chen, 1996) states that gestures help a speaker access words from the mental lexicon, by boosting activation of the to-be-retrieved item. This is based on the notion that gestures are derived from spatially encoded knowledge and play a role in generating the surface forms of utterances. Evidence consistent with this theory comes from studies that find higher rates of gesturing during spontaneous speech than rehearsed speech (e.g. Chawla & Krauss, 1994); that a gesture precedes the articulation of the word and is then terminated (Morrel-Samuels & Krauss, 1992; Pine, Lufkin, & Messer, 2007), and that word finding is impaired when gesturing is restricted (Frick-Horbury & Guttentag, 1998; Pine, Bird, & Kirk, 2007).

These approaches are by no means dichotomous or mutually exclusive. Scrutiny of the evidence in favour of one view frequently reveals a degree of support for the other. For example, Jacobs and Garnham (2007) used monologue cartoon narratives that manipulated the communication and lexical access demands on the speaker, varying the novelty of both the target material and the listener. When a speaker repeated the same narration three times to the same listener, the rate of gesture fell over the course of the three narrations, suggesting it was not integral to speech but took account of the listener. Jacobs and Garnham acknowledge that the effects may be limited to this type of task and that "it is possible they are restricted to a particular category of gesture" (p. 297). Their caution is warranted, since half as many gestures still appeared in the condition where communication and lexical demands were low. When evaluating the lexical and communicative contributions the authors conclude that “gestures may serve both functions although in different contexts the primary function may vary” (p.292).

In an attempt to establish whether gestures play more of a role in speech production (the Lexical Access Hypothesis) or in thinking for speech (the Information Packaging Hypothesis) with children, Alibali, Kita, & Young (2000) varied the lexical and conceptual demands made upon them. They gave children a Piagetian conservation task and asked them to either *explain* the task or to *describe* it, rationalising that explaining would make conceptual demands, whereas description would only tax the lexical system. Children produced more gestures in the explanation condition than in the description condition. The authors concluded that gestures must be primarily involved in the conceptual planning of utterances but did not rule out the possibility that gesture may also facilitate lexical retrieval; after all, explanations may require more complex language than descriptions.

These and other findings lead us to suggest that it may be fruitful to move away from polarising the gesture-function debate around speaking-or-thinking arguments. Indeed, both views are consistent with embodied cognition approaches, whereby language is grounded in bodily action. A dynamical interplay between communicative, linguistic and cognitive factors, with gestures acting as cross-modal primes transversing the processes, cannot be ruled out.

Further light is shed on this interplay by priming effects found in the action literature, particularly effects arising from the compatibility between hand posture and representation of objects (e.g. Glenberg & Kaschak, 2002; Hommel, Musseler, Aschersleben, & Prinz, 2001). Fischer, Prinz, and Lotz (2008) demonstrated that presenting participants with a particular hand grasp posture caused them spontaneously to shift their attention to objects compatible with that posture. Ellis and

Tucker (2000) had already observed that, “the representation of a visual object includes not only a description of its visual properties, but also encoding of actions relevant to that object” (p.451), a view endorsed by evidence for a neural link between speech and action, whereby language and action recruit overlapping parts of the brain (Willems, Ozyurek, & Hagoort, 2007). Hauk, Johnsrude, and Pulvermuller (2004) monitored brain activity while participants read verbs referring to face, arm, or leg actions and found that articulating the verbs activated the brain areas adjacent to and overlapping those activated by movement of the corresponding body part. The pre-motor cortex, they concluded, is implemented in the representation of action words (see also Ehrsson, Geyer, & Naito, 2003).

Wheeler and Bergen (2006) demonstrated compatibility effects for the understanding of language, with hand-shape as the precipitating action. Participants made sensibility judgements of action sentences while producing a fist or open palm gesture. Response times were faster when the hand shape was congruent with the action sentences, suggesting that mental simulations incorporate motor detail. Zwaan and Taylor (2006), investigating whether comprehension of linguistic descriptions of actions comes from mentally simulating the actions, also found an action-compatibility effect. Again, response times were faster when the manual response was congruent with the action-sentence. Even body posture influences cognition. Dijkstra, Kaschak, and Zwaan (2007) found shorter response times during retrieval of autobiographical memories when body posture was congruent with that adopted during the original event. Body postures and gestures are examples of simulated actions that prime a range of cognitive processes, including language and memory, functioning both to reflect and facilitate these processes (Alibali & Nathan, 2007; Hostetter & Alibali, 2008).

Further evidence for bodily action-cognition links comes from the finding of a word-gesture Stroop-like effect. Gentilucci, Benuzzi, Bertolani, Daprati, and Gangitano (2000) asked participants to reach for objects, for example with the word ‘near’ or ‘far’ printed on them in Italian and which were placed either near to, or far from, the participant. Participants’ initial movements were affected by the word prime and when the printed words referred to extrinsic properties – such as near vs. far, or low vs. high – “a motor program was elaborated for reaching a target position congruent with the word meaning” (p. 488). So an object placed in a high position with the word ‘low’ printed on it would result in participants reaching for a lower position than where the object was placed. Words relating to the intrinsic properties – such as small vs. large – also affected the grasp of the object. These empirical findings, which are just a sample from the literature, mitigate the notion that gestures exist purely for communicative purposes.

If perception, cognition and action are dynamically inter-related in a non-sequential manner then similar effects to those found by Gentilucci et al. (2000) should be observable in reverse, beginning not with perception but with action. In other words, we predict that a compatible action will facilitate access to the representation of the object faster than an incompatible action. A congruent gesture is more likely to activate a spatial feature of the to-be-recognised object than an incongruent gesture and therefore to act as a cross-modal prime (from action to perception). This is the hypothesis under examination here, where we compare the effects of a congruent, an incongruent gesture and no gesture at all. Many of the congruency studies cited demand a binary motor response (e.g. Dijkstra et al., 2007; Ellis & Tucker, 2000) and fail to include a control condition where no gesture is produced (but see Skipper, Goldin-Meadow, Nusbaum, & Small, 2007). This precludes an examination of whether gestures might function to reduce the cognitive load for the speaker (Goldin-Meadow, 2000). If this is the case, then not gesturing should impose more of a cognitive burden than gesturing and therefore should be more detrimental than producing a congruent gesture.

We set out to test whether producing a congruent gesture facilitates object recognition, compared to producing an incongruent gesture or no hand movement at all. Participants are instructed to either produce a clenched fist gesture, a flat hand gesture (see Wheeler & Bergen, 2006), or no gesture, before being asked to identify degraded images that gradually increased in clarity. We predicted compatibility effects where the action was congruent with the target stimulus, i.e. priming retrieval of the correct word resulting in faster naming.

## Method

### *Participants*

Students (*N* = 122) from the University of Hertfordshire participated in return for course credit. There were 55 males and 67 females; age range 18 - 41 years (*M* = 25.33, *SD* = 4.46). All had English as their first language.

### *Design*

A within-subjects design with *condition* as the independent variable with three levels: *congruent gesture*, *incongruent gesture*, and *no gesture* and *time taken* to name the image correctly as the dependent variable.

### *Materials and Apparatus*

Thirty images were selected after first piloting a corpus of 100 with 20 independent adult judges. The final stimulus set was made up of the 10 images rated as most congruent with the closed fist gesture and the 10 rated as most congruent with the flat hand gesture. This was to rule out the possibility that any effects might be driven by just one or two images. Ten images with low congruency for either gesture formed the no gesture condition (see Appendix A). For example, an airplane was considered to be congruent with a flat hand gesture and a microphone with a closed fist gesture. The stimuli, derived from those developed by Viggiano, Vannucci, and Righi (2004), were of objects or animals, and presented in greyscale. Images were degraded over nine stages using a Gaussian blur mechanism in Adobe Photoshop.

A SuperLab 4 programme was used to present the images to the participants, using an Apple iBook. Images were randomised for presentation; ten images were accompanied by a congruent gesture, ten accompanied by an incongruent gesture, and ten not accompanied by a gesture. Counterbalancing was used in order to rule out any image effects, whereby half the participants saw a set of images while performing a congruent gesture and the other half of the participants saw the same images while performing an incongruent gesture (the no gesture image set were not counterbalanced). For example, one participant saw the image of an airplane whilst producing the congruent, *flat hand* gesture, whilst another participant saw it whilst producing the incongruent, *clenched fist* gesture. The order of presentation was also reversed for half of the participants, controlling for possible order effects.

*Procedure*

Participants undertook the experiment individually, in a quiet location seated at a table in front of the laptop computer with the experimenter alongside the computer, facing the participant. They were familiarised with the gesture instructions that would appear as images on the screen: a closed fist symbol, a picture of flat hand with open palm, and a large grey ‘X’ for no gesture. When a closed fist gesture was required the participants had to close their dominant hand to form a fist and hold it in front of them. When a flat hand gesture was required the participants had to open their dominant hand and hold it flat in front of them. When no gesture was required the participants had to keep their hands flat on the table in front of them. They were instructed that the required gesture should be produced as soon as the symbol appeared on screen and held for each image. They were told they could only provide one answer so should think carefully before answering. A practice trial familiarised participants with the procedure.

The gesture symbol appeared on screen for three seconds, the participant adopted the gesture then an image set was presented, first at a very degraded level and gradually increasing in clarity over nine stages. Each stage lasted for three seconds. The participant held the gesture until they provided the correct answer. The computer screen was not visible to the experimenter, who was blind to the condition, but who referred to a list of correct responses for each trial and clicked the mouse when a correct response was given. The programme then moved to the next trial.

## Results

These results consider the response latencies, from first presentation of the image to producing the correct response under each condition, congruent gesture, incongruent gesture, and no gesture.

### *Naming Times*

Response latencies were shortest when participants produced a congruent gesture (*M* = 12.03 seconds, *SD* = 1.74) and longest when producing an incongruent gesture (*M* = 12.80 seconds, *SD* = 2.02). Latencies for the no gesture condition fell in between (*M* = 12.44 seconds, *SD* = 1.44).

*Insert Figure 1 about here*

The data were subjected to a repeated measures one-way analysis of variance (ANOVA) with response time as the within-subjects dependent variable and three levels of the independent variable, congruent gesture, incongruent gesture, and no gesture. Mauchly's test indicated that the assumption of sphericity had been violated, so the degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity. A significant main effect was found for condition, $F(1.69, 203.98) = 11.14$, $p < .01$. Follow-up paired t-tests were used to analyse the pair-wise differences, with a significance level of .017 for each test, creating a family wise error rate of 0.05. Response latencies were faster with a congruent gesture than with an incongruent gesture, $t(121) = –3.98$, $p < .01$, or with no gesture at all, $t(121) = –2.597$, $p < .01$. Participants made very few errors and this precluded an analysis of error rates.

## Discussion

The aim of this study was to investigate whether producing a congruent gesture facilitates object recognition, compared to producing an incongruent gesture or no gesture at all. Participants were instructed to either produce a clenched fist, a flat hand or no gesture before identifying degraded images that gradually increased in clarity. As predicted, compatibility effects were found. When the action was congruent with the target stimulus this primed retrieval and resulted in faster naming.

These findings revealed not only that compatibility is facilitative, but also that incompatibility is detrimental and producing no gesture falls in between the two. The congruency effect suggests that gestures need not be closely matched to targets but need to convey relevant rather than meaningless information in order to activate features associated with the object. This cross-modal priming may be one route through which object naming is facilitated by gesture. Willems, Ozyurek, and Hagoort (2007) have shown that language and action recruit overlapping parts of the brain and share the same neural substrates, which suggests a stronger role for gesture in naming rather than in recognition. By recruiting more brain pathways when accessing the name for an object the speaker may be afforded greater speed of access.

A strength of this study is the inclusion of a condition where participants did nothing with their hands on some of the trials. This showed that it is better to gesture in a meaningful manner, than to produce no gesture at all, as participants were significantly slower on the ‘no gesture’ trials than on the congruent gesture trials. This is consistent with the cognitive load hypothesis (Goldin-Meadow 2000) and provides further evidence that gesturing is an integral part of the speaker’s cognitive process.

Participants were slowest on the trials where the gesture they produced was incongruent with the target object. One example of this might be producing a flat hand before presentation of a hammer, or a clenched fist before a butterfly. An incongruent gesture was more detrimental to their performance than producing no gesture at all. One explanation for this is that the incongruent gesture activated features not associated with the target object or an unrelated motor pathway. The effects of an incongruent gesture could therefore be described as a ‘diversion’ – rather than facilitating access to the representation; it takes the thinker on a lengthier and therefore slower route to object name retrieval (Wheeler & Bergen, 2006; Zwaan & Taylor, 2006). In relation to the cognitive load hypothesis it could be argued that the production of an incongruent gesture increases the cognitive burden, with cognitive resources being unnecessarily expended on semantic ambiguity and so inhibiting retrieval.

The detrimental effect of an incongruent gesture also brings into question the claim that any motor movement can act as an aid to lexical access (e.g. Ravizza, 2003). The mapping between gesture and object representation in this study was not strong, with the gestures only minimally representing semantic information about the object. Yet there was high agreement amongst the raters during piloting as to the congruency/incongruency of the gestures with the targets, and during testing these proved to have been close enough to yield a compatibility effect. Masson, Bub, and Newton-Taylor (2008) noted that “even though the mental representation… may not completely fit the action…the parameter sets that define these two activities should be sufficient to yield a priming benefit.” (p. 873). These data suggests they were sufficient.

The images used in this study were derived from a larger set of Viggiano, Vannucci, and Righi (2004) from which we extracted 10 items rated to be congruent with a clenched fist gesture, 10 with a flat hand gesture and 10 items unrelated to either gesture. It is possible that some images were easier to identify because of their distinctive shapes e.g. a butterfly or a guitar, although counterbalancing would have ruled out these having an effect. It was not possible also to control, and therefore counterbalance, the proportion of manipulable objects in the target sets, although many had a high praxic content. Evidence from neuropsychological studies proposes that motoric action is related to speech production and since motor actions are performed on praxic objects, this suggests the presence of a strong spatio-motoric component underlying the semantic representation. For example Wesp, Hesse, and Keutmann (2001) contend that gestures maintain spatial concepts in memory during lexical search. This is consistent with the Gestural Feedback Model (Morsella & Krauss, 2004), which ascribes more than direct lexical facilitation to gesture. Their model argues for gestures activating features that make up the semantic representations of target words through feedback from effectors or motor commands, and is consistent with findings of localised motor cortex activation when people name an object with praxic properties (Weisberg, van Tournennout, & Martin, 2007). Congruent, iconic gestures would have expressed the activation of the motor programs associated with the actions of objects and it could be argued that a clenched fist is a motor action more commonly associated with acting on an object than a flat hand. However, whether the congruent gesture was a fist or a flat hand, it appeared to be congruency rather than gesture type that facilitated object recognition, although future studies could confirm this by exploring whether some hand postures are more facilitative than others.

One cannot also rule out whether the production of the gesture by the participant was necessary or whether simply seeing the gesture on screen would have been enough to produce an effect, via the mirror neuron system (Gallese et al., 1996; Rizzolatti & Arbib, 1998; Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). Neuroimaging studies have demonstrated that the processing of certain words or sentences activates the same neural regions as the actual actions associated with the words. Fadiga, Fogassi, Pavesi, & Rizzolatti (1995), furthermore, showed that watching another person grasp an object prompted muscular activity in participants consistent with them grasping the object themselves. The question of whether viewing the gesture alone could have produced an effect equivalent to executing the motor action associated with it in this study remains tantalisingly unanswered. Future studies could explore this, and also employ voice recognition technology to record participants' responses since, although we took reasonable steps to remove experimenter bias and recording error, we cannot be sure the current design excluded these completely.

These findings add to the growing weight of evidence that suggests that, as well as having an interpersonal, communicative function, gestures also serve an intrapersonal cognitive purpose. Bodily actions, postures, and gestures can trigger access to memories, representations, and language suggesting they have a positive benefit for the speaker, aside from the communicative enhancement derived by the addressee. Furthermore, they add to the evidence for the interrelatedness between language, bodily actions, and cognition, an overlap that is now supported by neural evidence.

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**References**

Alibali, M. W., & Nathan, M. J. (2007). Teachers' gestures as a means of scaffolding students' understanding: Evidence from an Early Algebra Lesson in R. Goldman, R. Pea, B. Barron, & S. J. Derry (Eds.), *Video Research in the Learning Sciences*. Mahwah, NJ: Erlbaum.

Alibali, M. W., Flevares, L. M., & Goldin-Meadow, S. (1997). Assessing knowledge conveyed in gesture: Do teachers have the upper hand? *Journal of Educational Psychology, 89* (1)*,* 183-193.

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., & Shovelton, H. (1999). Do iconic gestures really contribute anything to the semantic information conveyed by speech? *Semiotica, 123*, 1-30.

Chawla, P., & Krauss, R. M. (1994). Gesture and speech in spontaneous and rehearsed narratives. *Journal of Experimental Social Psychology, 30*(6*)*, 580-601.

Church, R. B., & Goldin-Meadow, S. (1986). The mismatch between gesture and speech as an index of transitional knowledge. *Cognition, 23*(1), 155-192.

Cohen, A. A. (1977). The communication functions of hand illustrators. *Journal of Communication, 27*(4), 54-63.

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.

Dijkstra, K., Kaschak, M. J., & Zwaan, R. A. (2007). Body posture facilitates retrieval of autobiographical memories. *Cognition, 102*(1), 139-149.

Ehrsson, H. H., Geyer, S., & Naito, E. (2003). Imagery of voluntary movement of fingers, toes, and tongue activates corresponding body-part specific motor representations. *Journal of Neurophysiology, 90*(5), 3304-3316.

Ellis, R., & Tucker, M. (2000). Micro-affordance: The potentiation of components of action by seen objects. *British Journal of Psychology, 91*(4), 451-471.

Fadiga, L., Fogassi, L., Pavesi, G., & Rizzolatti, G. (1995). Motor facilitation during action observation: A magnetic stimulation study. *Journal of Neurophysiology, 73*(6), 2608-2611.

Fischer, M. H., Prinz, J., & Lotz, K. (2008). Grasp cueing shows obligatory attention to action goals. *Quarterly Journal of Experimental Psychology, 61*(6), 860-868.

Frick-Horbury, D., & Guttentag, R. E. (1998). The effects of restricting hand gesture production on lexical retrieval and recall. *American Journal of Psychology, 111*(1), 43-62.

Gallese, V., Fadiga, L., Fogassi, L., & Rizzolatti, G. (1996). Action recognition in the premotor cortex. *Brain, 119*(2), 593-609.

Gentilucci, M., Benuzzi, F., Bertolani, L., Deprati, E., & Gangitano, M. (2000). Language and motor control. *Experimental Brain Research, 133*(4), 468-490.

Glenberg, A. M., & Kashak, M. P. (2002). Grounding language in action. *Psychonomic Bulletin & Review, 9*(3)*,* 558-565.

Goldin-Meadow, S. (1999). The role of gesture in communication and thinking. *Trends in Cognitive Sciences, 3*(11), 419-429.

Goldin-Meadow, S. (2000). Beyond words: The importance of gesture to researchers and learners. *Child Development, 71*(1), 231-239.

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

Hommel, B., Musseler, J., Aschersleben, G., & Prinz, W. (2001). The theory of event coding (TEC): A framework for perception and action planning. *Behavioural and Brain Sciences, 24*(5)*,* 849-937.

Hostetter, A. B., & Alibali, M. W. (2008). Visible embodiment: Gestures as simulated action. *Psychonomic Bulletin, 15*(3)*,* 495-514.

Hostetter, A. B., Alibali, M. W., & Kita, S. (2007). I see it in my hand's eye: Representational gestures reflect conceptual demands. *Language and Cognitive Processes, 22*(3)*,* 313-336.

Jacobs, N., & Garnham, A. (2007). The role of conversational hand gestures in a narrative task. *Journal of Memory and Language, 56*(2), 291-303.

Kendon, A. (1980). Gesticulation and speech: Two aspects of the process of utterance. In M. R. Key (Ed.), *The relation between verbal and nonverbal communication* (pp.207-227). The Hague: Mouton.

Kendon, A. (1987). On gesture: Its complementary relationship with speech. In A. Siegman & S. Feldstein (Eds.), *Nonverbal communication* (pp. 65-97). Hillsdale, New Jersey: Erlbaum.

Kita, S. (2000). How representational gestures help speaking. In D. McNeill (Ed.), *Language and gesture* (pp. 162-185). Cambridge: Cambridge University Press.

Krauss, R. M., Chen, Y., & Gottesman, R. F. (2001). Lexical gestures and lexical access: A process model. In D. McNeill (Ed.), *Language and gesture: Window into thought and action* (pp. 261-283). New York: Cambridge University Press.

Masson, M.E.J., Bub, D.N., & Newton-Taylor, M. (2008). Language-based access to gestural components of conceptual knowledge. *The Quarterly Journal of Experimental Psychology, 61*(6), 869-882.

McNeill, D. (1992). *Hand and Mind*. Chicago: University of Chicago Press.

Morrel-Samuels, P., & Krauss, R. M. (1992). Word familiarity predicts temporal asynchrony of hand gestures and speech. *Journal of Experimental Psychology: Learning, Memory and Cognition, 18*(3), 615–623.

Morsella, E., & Krauss, R. M. (2004). The role of gestures in spatial working memory and speech. *The American Journal of Psychology, 117*(3), 411-424.

Pine, K. J., Bird, H., & Kirk, E. (2007). The effects of prohibiting gesture on children's lexical retrieval ability. *Developmental Science, 10*(6), 747–754.

Pine, K. J., Gurney, D. J., & Fletcher, B. (C) (2011). The semantic specificity hypothesis: When gestures do not depend upon the presence of a listener. *Journal of Nonverbal Behaviour, 34*(3), 169-178.

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

Pine, K. J., Lufkin, N., & Messer, D. J.  (2007). A microgenetic analysis of the relationship between speech and gesture in children: Evidence for semantic and temporal asynchrony. *Language and Cognitive Processes, 22*(2), 234 – 246.

Prinz, W. (1997). Perception and action planning. *European Journal of Cognitive Psychology, 9*(2), 129-154.

Pylyshyn, Z. (1999). Is vision continuous with cognition? The case for cognitive impenetrability of visual perception. *Behavioral and Brain Sciences, 22*(3), 341-365.

Rauscher, F. H., Krauss, R. M., & Chen, Y. (1996). Gesture, speech and lexical access: The role of lexical movements in speech production. *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.

Rime, B. (1982). The elimination of visible behaviour from social interactions: Effects on verbal, nonverbal and interpersonal variables. *European Journal of Social Psychology, 12*(2), 113-129.

Rizzolatti, G., & Arbib, M. A. (1998). Language within our grasp. *Trends in Neuroscience, 21*(5), 188-194.

Rizzolatti, G., Fadiga, L., Gallese, V., & Fogassi, L. (1996). Premotor cortex and the recognition of motor actions. *Cognitive Brain Research, 3*(2), 131–141.

Singer, M. A., & Goldin-Meadow, S. (2005). Children learn when their teacher's gestures and speech differ. *Psychological Science, 16*(2), 85-89.

Skipper, J., Goldin-Meadow, S., Nusbaum, H. C., & Small, S. L. (2007). Speech-associated gestures, Broca's area, and the human mirror system. *Brain and Language, 101*(3), 260-277.

Thurnham, A.J., & Pine, K. J. (2006). The effects of single and dual representations on children's gesture production. *Cognitive Development, 21*(1), 46-59.

Viggiano, M. P., Vannucci, M., & Righi, S. (2004). A new standardised set of ecological pictures for experimental and clinical research on visual object processing. *Cortex, 40*(3), 491-509.

Weisberg, J., van Turennout, M., & Martin, A. (2007). A neural system for learning about object function. *Cerebral Cortex, 17*(3) 513-521.

Wesp, R., Hesse, J., & Keutman, D. (2001). Gestures maintain spatial imagery. *American Journal of Psychology, 114*(4), 591-600.

Wheeler, K. B., & Bergen, B. K. (2006) Meaning in the palm of your hand. In S. Rice & J. Newman (Eds.), *Empirical and Experimental Methods in Conceptual Structure, Discourse and Language* (pp.2-13). Stanford: CSLI.

Willems, R. M., Ozyurek, A., & Hagoort, P. (2007). When language meets action: The neural integration of gesture and speech. *Cerebral Cortex, 17(*10), 2322-33.

Zwaan, R. A., & Taylor, L. J. (2006). Seeing, acting, understanding: Motor resonance in language comprehension. *Journal of Experimental Psychology, 135*(1), 1-11.

Appendix A

Items judged to be congruent with a **flat, open hand gesture**:
Airplane
Bed
Books
Butterfly
Computer
Plates
Piano
Door
Rolling pin
Ladder

Items judged to be congruent with a **closed fist gesture**
Hairbrush
Iron
Hammer
Kettle
Knife
Microphone
Mug
Telephone
Tennis Racket
Screwdriver

Items not judged congruent with either gesture
Banana
Camera
Chair
Football
Glasses
Mouse
Guitar
Puppy
Shoes
Umbrella

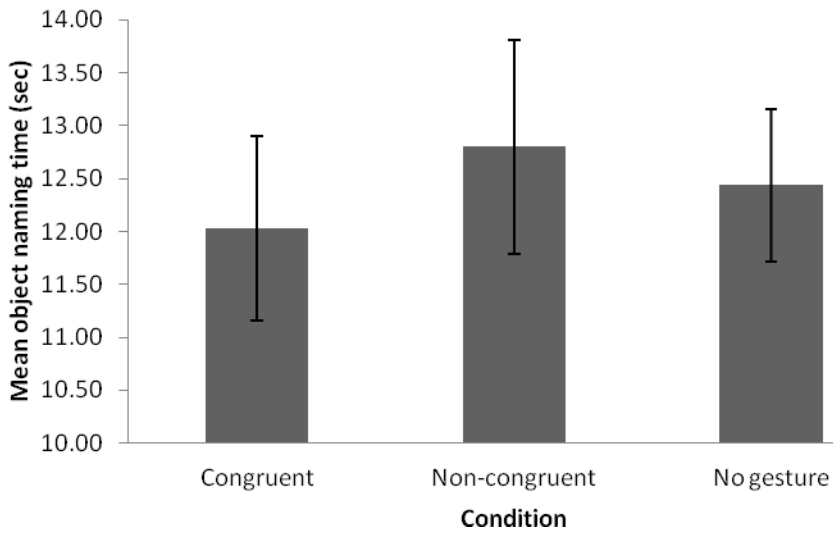


Figure 1. Mean object naming times (in seconds) for each condition. The error bars represent standard deviations.