



Effects of imitating gestures during encoding or during retrieval of novel verbs on children's test performance



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ARTICLE INFO

Article history:

Received 15 November 2012

Received in revised form 28 May 2013

Accepted 30 May 2013

Available online 29 June 2013

PsychInfo codes:

2340

2343

Keywords:

Word learning

Motor action

Embodiment

Imitation

Gestures

ABSTRACT

Research has shown that observing and imitating gestures can foster word learning and that imitation might be more beneficial than observation, which is in line with theories of Embodied Cognition. This study investigated when imitation of gestures is most effective, using a $2 \times 2 \times 2 \times 3$ mixed design with between-subjects factors Imitation during Encoding (IE; Yes/No) and Imitation during Retrieval (IR; Yes/No), and within-subjects factors Time of Testing (Immediate/Delayed) and Verb Type (Object manipulation/Locomotion/Abstract). Primary school children ($N = 115$) learned 15 novel verbs (five of each type). They were provided with a verbal definition and a video of the gesture. Depending on assigned condition, they additionally received no imitation instructions, instructions to imitate the gesture immediately (i.e., during encoding; IE), instructions to imitate (from memory) during the first posttest (i.e., during retrieval; IR), or both (IE–IR). Based on the literature, all three imitation conditions could be predicted to be more effective than no imitation. On an immediate and delayed post-test, only the object-manipulation verbs were differentially affected by instructional method, with IE and IR being more effective than no imitation on the immediate test; IE–IR and no imitation did not differ significantly. After a one week delay, only IR was more effective than no imitation, suggesting that imitation during retrieval is most effective for learning object-manipulation words.

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1. Introduction

Gestures, defined here in accordance with the Oxford English Dictionary as “movements of the body or parts of the body”, are ubiquitous and serve an important function in communication (Goldin-Meadow, 1999). However, because gestures are even used when they have no obvious function (e.g., when there is no visual contact with the interlocutor; Rimé, 1983), they are thought to have not only communicative functions, but cognitive ones as well (Kita, 2000). Given that language and the motor system are closely connected (Fischer & Zwaan, 2008) and that speech and gestures even seem to share the same communication system (Bernardis & Gentilucci, 2006), theories of Embodied Cognition would predict that gestures have a function in language learning.

In line with this assumption, it has been shown that *observation* of gestures can improve word learning. A study in which five year old children received verbal instructions with or without observation of congruent gestures showed that observation improved memorization of a list of concrete nouns and descriptive adjectives (Tellier, 2005). In addition, gesture observation seems to have benefits for application of new information as well (Ping & Goldin-Meadow, 2008).

Next to observation, *gesture imitation* has been shown to improve word learning. For example, children can remember more items from a list with familiar concrete nouns and descriptive adjectives when imitating gestures that accompany the words than when only observing these gestures, an effect that was found both for words from the first language (Tellier, 2005) and for words from a second language (Tellier, 2008). These findings suggest that imitation of gestures might have a beneficial effect on learning the meaning of verbs over and above mere observation of the same gestures. However, these studies applied imitation during encoding, immediately after observation. An interesting open question that we address here is what the effects on test performance would be of imitating the gestures that were observed during encoding, in the retrieval phase. Whereas imitation while hearing new words may facilitate encoding of information, imitation during retrieval (or test taking) might provide children with additional cues that could foster the retrieval of previously learned words from memory. Imitation at both of these stages might be even more effective for learning, aiding both encoding and retrieval.

1.1. Imitating gestures during encoding

In the speech production literature, it has been hypothesized that gestures can facilitate speech production, because they facilitate conceptual storage before the information has a linguistic form. That is, gestures would translate spatio-motoric knowledge into linguistic

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units (Kita, 2000). A similar mechanism might apply to encoding new verbal information. The Image Maintenance Theory (De Ruiter, 1998; Wesp, Hesse, Keutmann, & Wheaton, 2001) proposes that gestures facilitate the maintenance of spatial representations in working memory. According to this theory, gestures activate images in working memory and can reactivate visuo-spatial information which might facilitate encoding. Indeed, as mentioned above, imitation during encoding has been found effective in language learning (e.g., Tellier, 2007, 2008; see also findings with adults by Kelly, McDevitt, & Esch, 2009; Macedonia & Knösche, 2011).

1.2. Imitating gestures during retrieval

From domains other than language learning, there are indications that spontaneous gesturing (i.e., not specifically imitating previously observed gestures) during the recollection of a previous event, improves recall compared to when children are prohibited from gesturing (Stevanoni & Salmon, 2005). Similarly, recall of verbal material has been shown to improve when adults are cued with self-generated hand gestures compared to when they are not cued (Frick-Horbury, 2002). Moreover, when people were prohibited from gesturing during speech with spatial content, they were less fluent than when gesturing was allowed, which shows that lexical access is disrupted (Rauscher, Krauss, & Chen, 1996). These findings are in line with the Lexical Retrieval Hypothesis (Rauscher et al., 1996), which states that gestures facilitate retrieval of items from the mental lexicon. So even though none of these studies looked specifically at imitating previously observed gestures, these findings do suggest that imitation of a gesture during retrieval could facilitate the recall of previously learned words.

1.3. Imitating gestures during encoding and retrieval

Finally, the combination of imitation during encoding as well as retrieval might be most effective for word learning, according to the Encoding Specificity Principle (Tulving & Osler, 1968). This hypothesis states that retrieval of information is more likely when the overlap between the context at encoding and the context at retrieval is high. For example, when participants were presented with weakly associated cue–target word pairs, recall of the target words was higher when participants were cued with the same weakly associated word than when they were cued with another weakly associated cue or when free recall was used (Tulving & Osler, 1968). Also, when memorizing a list of words under water, recall of the words was better when words were retrieved under water than when retrieval took place on dry land (Godden & Baddeley, 1975) showing that the context in which a word is learned can aid recall. Although these studies did not use gestures, the Encoding-Specificity Hypothesis suggests that an effective way to improve recollection would be to imitate observed gestures both during the encoding phase and the retrieval phase. The gestures made during encoding are then part of the mental representation of the new word, and activating this part of the mental representation during retrieval might facilitate recall.

The present study investigates the effectiveness of these three different ways of imitating observed gestures, on 9-to-10 year old children's learning of novel verbs in their first language.

1.4. Effects of imitation on verb learning

Verbs are a particularly interesting word class for studying the effects of imitating gestures on learning, given the existence of verbs that have a direct link to the motor system (e.g., to stride, to chisel) and verbs that do not have a direct link to the motor system (e.g., to dismiss, to recruit). Most studies that have investigated the role of the motor system in understanding language using verbs have used object-manipulation verbs or functionally manipulable verbs (e.g., Rueschemeyer, Lindemann, Van Rooij, Van Dam, & Bekkering,

2010; Tessari, Canessa, Ukmar, & Rumiati, 2007; Willems, Labruna, D'Esposito, Ivry, & Casasanto, 2011). However, object-manipulation verbs are just one class of action verbs and it is important to investigate whether effects of imitating gestures during encoding, retrieval, or both are the same for various types of verbs, such as locomotion verbs (e.g., to stride) or abstract verbs (e.g. to dismiss).

Whereas object-manipulation verbs are mostly manual verbs, locomotion verbs require leg activation. These verbs therefore activate different parts of the motor cortex (e.g., Hauk, Johnsrude, & Pulvermüller, 2004; Tettamanti et al., 2005, see also: Hickok, 2010). Because of the close coupling between language and manual gestures (Gentilucci & Corballis, 2006), it is possible that verbs coupled to manual gestures might be learned better through imitation than verbs coupled to non-manual gestures, as is the case for the locomotion verbs. Furthermore, while both object-manipulation and locomotion verbs can be goal-directed, locomotion verbs do not always denote intentional goal-directed activities (e.g., to stroll). Research has shown that the mirror neuron system (Rizzolatti & Craighero, 2004) is more active for goal-directed actions than for non-goal-directed actions (Nyström, Ljunghammar, Rosander, & von Hofsten, 2011), which might aid imitation. Imitation involves a decomposition of motor patterns into constituent components and later a reconstruction of the action pattern from these components. This decomposition is guided by an interpretation of the motor pattern as goal directed behavior (e.g., Bekkering, Wohlschläger, & Gattis, 2000), suggesting that actions may be harder to imitate when they are not goal-directed. Thus, these findings suggest that motor activation resulting from imitating gestures could be stronger and therefore perhaps more beneficial for learning object-manipulation verbs than for learning locomotion verbs.

Both object-manipulation and locomotion verbs are action verbs and have an obvious connection to the motor system, which abstract verbs do not have. According to pure theories of Embodied Cognition, cognition is completely grounded in the sensory-motor system, and accordingly, this view would predict that such grounding should exist for abstract concepts as well (e.g., Pecher, Boot, & van Dantzig, 2011; Wilson, 2002), in which case imitation can be expected to facilitate learning of abstract verbs as well. For instance, given that the abstract concept of time can be understood in terms of spatial experience (Boroditsky & Ramscar, 2002), abstract concepts could refer indirectly to bodily experiences (Borghi, Caramelli, & Setti, 2005).

1.5. The present study

In summary, we will investigate the effects of different instructional conditions (i.e., no imitation, imitation during encoding, imitation during retrieval, imitation during both encoding and retrieval) on learning of novel verbs in the children's first language (Dutch). Learning will be measured both immediately and at a delay. This is done not only because it has been shown that the effect of observing and producing gestures might not emerge immediately, but only after a certain delay (e.g., Cook & Fenn, 2010; Macedonia & Knösche, 2011), but also because it is relevant from a practical (i.e. educational) perspective to investigate whether effects of imitating gestures persist or change over time. For word learning it is not that relevant to be able to remember a definition straight after you have heard it. It is far more important to remember what the word means after a longer interval, so that the knowledge of the word can actually be used when it is encountered in other contexts and the word can be added to the active vocabulary.

Our review of the literature leads to several hypotheses concerning the effect of the different instructional conditions in relation to verb type (i.e., locomotion, object-manipulation, and abstract). We expect children to learn more words in the imitation conditions (during encoding, during retrieval, or both) than in the no imitation (i.e., observation only) condition, based on studies that found an effect of gesture imitation over gesture observation (e.g., Tellier, 2007). We expect this

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