Spring 5-1-2014

Talking Hands: Does gesture production help bilingual preschoolers learn words?

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A Capstone Project Submitted in Partial Fulfillment of the Requirements of the Renée Crown University Honors Program at Syracuse University

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May 2014

Honors Capstone Project in Communication Sciences and Disorders

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Date: April 30, 2014

Abstract

As multilingualism grows throughout the world, so does the need to develop appropriate teaching methods for the multilingual population, especially during the crucial stages of language acquisition that occur during childhood. Bilingual children must develop two vocabularies concurrently; this is a difficult task for many, but non-speech expression of language such as gestures may aid the process of acquiring new words in one's vocabulary. The mirror neuron system provides a physiological basis for the connection between language centers in the brain and the execution and observation of hand movements. To examine how using gestures affects children's word learning, the researcher taught nouns that were science vocabulary words using a single-subject, alternating treatments design with two different conditions: speech production and speech and gesture production. The design was replicated across two children. The results suggested that gesture may have facilitated learning of new words in one child, but not the other. Reasons for such individual differences will be discussed.

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Executive Summary

Background:

Bilingual children have different language development than monolingual children. For instance, in the early years, bilingual children typically have smaller vocabularies in each of their languages, even though the number of words in their complete combinedvocabulary is similar to the number in a monolingual child's vocabulary. This may be why bilingual children have been incorrectly labeled with learning delays or disabilities at times. Furthermore, most teaching and speech therapy methods have been developed for and used with monolingual children; few techniques have been developed to help bilingual children learn new words during the critical stages of language development that occur during the preschool years.

Many studies have shown that non-speech expression of language such as gestures may aid the process of acquiring new words in one's vocabulary. In addition, the mirror neuron system provides a physical basis for the connection between language centers in the brain and watching and using hand movements. In this system, certain neurons (brain cells) in one of the language centers in the brain are activated when a person sees a gesture and when she performs that same gesture. This implies that gesture is an integral part of language comprehension, learning and production.

To examine the effect of gesture use on bilingual children's word learning, I employed an experimental method to teach object science vocabulary words using two different conditions: speech production and speech and gesture production.

Research question:

Does producing a gesture while saying a word help bilingual children learn a set of new words faster than just repeating the words? Tellier (2008) demonstrated that French monolingual children (with no previous exposure to English) memorized more English words when they were instructed to reproduce gestures while saying the words (without seeing a picture) than children who simply repeated the words while seeing a picture. Her study addressed the effects of teaching with gesture in a weekly class and using words commonly known to preschoolers. The children in both groups recalled the same number of words in a passive vocabulary test (pointing to the appropriate picture or showing the appropriate gesture), but when asked to produce the words, the group that gestured recalled significantly more than the group that repeated words. This provides support for the hypothesis that gesture production will help bilingual children learn new words as well.

The current study examines the effect of gesture production on word learning in children who are already developing English along with another language, with teaching done in an individual context. It also involves teaching new science vocabulary words instead of teaching the English word for an item a

child may already have in his or her vocabulary. In addition, the children in the current study were 4;6 and 5;1 years of age, whereas Tellier's study obtained information from older children who may have been at different developmental levels (4;11-5;10 years of age).

Design:

I taught object words using a single subject, alternating treatments design, done with 2 different children. For each individual child, the design allowed me to compare two modes of teaching words: asking the child to repeat words and asking the child to repeat words with simultaneous gestures. These words were drawn from a list of object words (nouns) that the children were not expected to know (they came from first-grade science curricula) and their lack of knowledge was confirmed prior to starting teaching.

Participants:

Participants were recruited through the Syracuse University Daycare, based on teacher recommendations and parent interest. The daycare serves employees and students of the university, so the children there have a variety of cultural and linguistic backgrounds. Classroom activities are conducted entirely in English.

The first participant, S01, was a Turkish-English bilingual female 5;1 years of age. Her primary language is Turkish, and she began learning English at 3 years of age. Turkish is the predominant language spoken at home, although

two of her older siblings speak English with her. The second participant, S02, was a Nepali-English bilingual male 4;6 years of age. His primary language is Nepali, and he began learning English between 1 and 2 years of age. Nepali is the predominant language spoken at home.

Methods:

In a screening session, I asked the children to tell me the word for a black-and-white image I had on an iPad. There were 22 of these pictures. I used this preliminary assessment to choose 10 object words that the children did not know, and then the words randomly were assigned to each condition (5 words to each condition).

In order to teach those words in the two conditions—Speech Only (SO) and Speech+Gesture (S+G)—and compare learning, I worked with each child three times per week at the daycare. During each of these sessions, I first asked the child to tell me what the word was for each picture to assess their memory of the words I had taught. To teach target words without gesture, I showed the child a picture of the target object on an iPad, said a sentence that helped the child understand what the words meant, and said the word. For target words with gesture, I showed the child a picture of the target object on the iPad, said a sentence that helped the child understand the word's meaning and said the word, accompanied by a gesture. All 10 words were taught during each session. After teaching, I then went through the pictures and asked the children to tell me my word for the picture. If they answered correctly, I confirmed that they were

correct, and if they answered incorrectly, I told them the correct word. This way, they understood that I wanted them to remember the new word I was teaching them instead of a word or paraphrase they may have used.

Results:

During each session, S01 always performed better on object words being taught with a gesture and ultimately learned 5 out of 5 object words with gesture and only 3 out of 5 without gesture. This provides support for the hypothesis that learning words with gesture production facilitates learning more than just repeating the word. However, S02 learned 5 out of 5 object words without gesture and only 2 out of 5 with gesture. This may have been caused by a lower level of motor and language skills due to his age and also individual differences in learning style. In addition, there may be cultural differences in the use of gesture in Turkish and Nepali, so it may be beneficial to consider language usage and gesture development in the children's native languages in future studies.

Future Implications:

Aside from the age difference between the two children, there may have been a difference in learning style. Since different people learn better in different contexts, it is possible that S01 is more of a visual and kinesthetic learner. On the other hand, S02 may be more of an auditory learner and it is even possible that simultaneous gesture made the task more difficult for him. This also may be related to the communication style of that individual (i.e., personality factors) and

to the gesture frequency of those who provide input, such as family members and caregivers. Neither child was assessed for his or her learning style, and so it will be important to include that variable in future research.

Since most teaching and speech therapy methods are based on knowledge of monolingual children's development, the limitations they place on educational professionals' abilities to teach bilingual children to communicate may be remedied by further developing new techniques to promote learning; I hope that this research will add to the body of research on teaching with gestures.

Considering the limited scope of this single-subject design, these findings are not generalizable to other bilingual children. My advisor and I intend to repeat the procedures employed in this study in an attempt to discover a more predictable pattern of learning and to extend the procedures to other linguistic elements (e.g., verbs). Replicating findings over several single-subject designs may then speak to the possibilities that gesture holds as a teaching technique. The results from S01 indicate that teaching English vocabulary words with gesture production may be beneficial to some bilingual children, and therefore further research is needed to determine who it may benefit and in what contexts.

Acknowledgements

This research would not have been possible without the help of the following:

Dr. Linda Milosky
Dr. Amanda Brown
Dr. Tanya Eckert
Dr. Eric Holzwarth

Syracuse University Daycare & Staff
Holley Benjamin
Cheryl Walsh
Erin Thompson
Participants and parents

Introduction

Embodied cognition refers to the scientific hypothesis that body and mind are not isolated from each other; rather, phenomena such as physical actions are considered an influence on how we think (Anderson, 2003). Research on the connection between movement and cognition has demonstrated influences of movement on judgments. Wells and Petty (1980) found that nodding the head led individuals to have more positive attitudes towards persuasive messages than when they shook their heads back and forth; similarly Schubert (2004) found that making a fist had an influence on how individuals processed and understood the concept of power. Within the realm of language processing, Glenberg (2008) suggested that physical experiences are what ground abstract language concepts in the mind. Recently, an emerging body of evidence has suggested that the non-oral motor representations of words may enhance comprehension and learning of language. (Rosborough, 2012; McCafferty, 2008; Stevanoni & Salmon, 2005; Cameron & Xu, 2011; Kelly, McDevitt, & Esch, 2009; Tellier, 2008). Based on this literature, the present study examines the relationship between gesture and language in children's word learning. It focuses upon the effects gesture has on such learning in bilingual children, who have to learn and process more than one language system at the same time. The specific question of this study addresses whether gesture may be used to enhance learning words unfamiliar to preschool bilingual children.

Gesture

Gesture has been defined as "any external expressive movement of the body which accompanies, supplements, or replaces oral speech" (Kaulfers, 1931, p. 249). Kendon (2004) describes gesture as an action that is an utterance. Though many think of gesture as an extra-linguistic cue—something that adds to the oral linguistic system—the current study aligns more closely with Kendon's view of gesture as an essential component of communication.

Gesture as an integral part of language

Though they are closely related, the terms communication, speech, and language differ in their meanings. Communication is the means by which people exchange ideas and information. Within communication, language is a socially shared system that allows people to convey concrete and abstract concepts (such as events or ideas displaced in time and space) through sounds and symbols and the rules that govern combination of those sounds and symbols (Owens, 2005). Speech is the oral expression of language. Kendon (2004) argues that gesture and speech are highly integrated forms of expression. However, it is also possible for people to communicate by using only gestures. Motioning "come here" is an example of this, although one does not directly say, "come here," the desire of the gesturer is perceived by the recipient.

Types of gesture

There are many ways for individuals to embody language. Three commonly used distinctions for gesture are: conventional gestures (common to a certain population, such a thumbs-up meaning "okay"), iconic gestures (where the

form of the gesture is related to its meaning, such as the hands forming a circle to indicate a "ball") and deictic gestures (pointing movements to indicate a static location or object, real or imagined) (McNeill, 1992). This is not an exhaustive list of types of gesture, but these three are very common in everyday interactions. Most studies find that conventional gesture is not as commonly used in *descriptive* conversation, but iconic and deictic gestures are (Pika, Nicoladis, & Marentette, 2006; Nicoladis, Pika, & Marentette, 2009; Nicoladis, 2002; Sherman & Nicoladis, 2004).

Neurological connections between action and language

Motor coordination is needed in order to produce specific speech sounds; it is also necessary for the control of hand movements that compose gesture. Fadiga, Craighero, and Roy (as cited in Glenberg et al., 2008, p. 908) showed that Broca's area, a part of the brain essential to language production, controls speech articulators as well as hand movements, which provides a foundation for the hypothesis that gesture and speech are part of an integrated system. In addition, research by Glenberg, Jaworski, Rischal, and Levin (2007) suggests that language comprehension is aided by simulating the meanings of words (such as the actions performed in a sentence) with the body. From observations of an English Language Learner (ELL) classroom, both Rosborough (2012) and McCafferty (2008) concluded that embodiment of a word helps a person to create meaning for that word. This relates to the idea of multimodal processing—that integrating both motor and sensory information assists in better recall because it creates more

connections in the brain than just sensory information (Macedonia & Knösche, 2011).

Broca's area is also activated during motor tasks and imitation tasks (Kircher, 2009; Heiser, Iacoboni, Maeda, Marcus, & Mazziota, 2003). The localization of this connection provides evidence for the existence of a mirror neuron system for hand movements in humans, a system that has been studied in monkeys. In this system, "the observed action seems to be 'reflected,' like in a mirror, in the motor representation for the same action of the observer" (Buccino, Binkifski, & Riggio, 2004, p. 371). The equivalent of Broca's area in monkeys, termed F5, contains these mirror neurons, and Rizzolatti et al. (as cited in Buccino et al., 2004) found that these neurons fired when monkeys observed and executed hand and mouth actions. There is some support for the existence of a similar system in the human brain; Broca's area is also activated while observing hand actions, which suggests that there is motor representation of the hands in that area of the brain (Glenberg et al., 2008). Also, although Broca's area is located near the bottom of the primary motor strip, it appears to be separate from that area of muscle control, further suggesting that the connection Broca's area has with the hands is not the same motor connection with the primary motor cortex. This emerging literature provides a neurophysiological basis for the assumption that gesture is an integral part of language comprehension, learning and production.

Development of gestures within language

In typical language development, comprehension precedes production of language. The input children receive—including spoken language, gestures, and

interpersonal interaction—is what they use in formation of their own language production skills. Some studies have shown that young children use gestures to communicate well before they begin to use words, and they may also combine single words and gestures together before they begin to combine words (Nicoladis, 2007). For instance, a child might say, "want," and point to an object to convey that she wants that item given to her. This development of gesture plus word usage is related to later syntactic and semantic development. For example, using gesture-plus-word combinations at 18 months is related to sentence complexity at 24 months (Fasolo & D'Odorico, 2012). Mayberry & Nicoladis (2000) observed that the more frequent and complex a person's gestures are, the more frequent and complex their speech utterances were. All of these studies have shown the link between gesture and spoken language in individuals who only speak one language. The current study aims to address a specific relationship between gesture and vocabulary learning in children who are acquiring more than one language.

Bilingualism

The American Speech-Language-Hearing Association (ASHA) defines bilingualism as the use of at least two languages by an individual (American Speech-Language-Hearing Association, 2004). ASHA also provides definitions for two types of bilingualism:

> "*Simultaneous bilingualism* occurs when a young child has had significant and meaningful exposure to two languages from birth. Ideally the child will have equal, quality experiences with both languages."

> "*Sequential bilingualism* occurs when an individual has had significant and meaningful exposure to a second language, usually after the age of 3 and after the first language is well established. These second language learners are referred to as 'English language learners' in U.S. schools."
>
> (ASHA, 2004).

As the latter definition suggests, the distinction between simultaneous bilingualism and sequential first (L1) and second (L2) language learning becomes blurred when working with very young children because they are within the critical period of language acquisition, and they develop and use both languages during that time. In addition, simultaneous bilingual children are often thought to have a primary language (L1) and an L2 even though they learn both languages at the same time. More often than not, L1 and L2 develop at different rates, and thus young sequential bilingual children may have similar levels of development as their simultaneous bilingual counterparts.

In examining the difference between bilingual and monolingual children, some studies show that bilingual children lag behind their monolingual peers in vocabulary acquisition for the first few years. Poulin-Dubois, Bialystock, Blaye, Polonia, and Yott (2012) compared the receptive and expressive vocabularies of monolingual and bilingual 2-year-olds and found that bilingual children had much smaller vocabularies in each language (L1 and L2), even though when these two vocabularies were added, they were roughly equal to the total number of words in monolingual children's vocabularies.

Other studies have proposed that bilingual children usually gesture more than their monolingual counterparts, no matter what language they speak (Pika et

al., 2006; Nicoladis et al., 2009; Nicoladis, 2002; Smithson, Nicoladis, & Marentette, 2011). However, variability in results of these studies may be due to differences in gesture types, languages and methods used.

Gesture use

Some cultures—such as Spanish- or French-speaking groups—have high frequencies of gesture use compared to English-speakers, while others (e.g., speakers of Mandarin or Japanese) use fewer gestures compared to English-speakers (Pika et al., 2006; Nicoladis et al., 2009). In addition, gestures are produced differently among languages; for instance, McNeill (2000) concluded that English and Spanish gestures differ in their path through space, sequencing and manner in which they are used to accompany oral language. When comparing gesture between Turkish and English native speakers, Özyürek et al. (2008) found that children as young as 3 years of age used gestures differently based on what their native language was (either Turkish or English). Also, Brown and Gullberg (2008) found that L1 gestures influence gesture when speaking in L2, and L2 gestures may influence gesture in L1, demonstrating the mutual influence of languages (rather than assuming only that L1 affects L2, as is typically assumed). Given these differences in frequency of use and nature of gestures, examination of gesture use in bilingual individuals is of great importance. This is particularly true as we begin to understand how learning more than one language may influence gesture and reciprocally how gesture use may influence language learning.

Gesture in bilingual children

Bilingual children's spoken language develops differently than monolingual children's, which suggests that their gesture development and use may also differ from that of monolingual children. Mayberry and Nicoladis (2000) showed that gestures developed along with bilingual children's oral language, and the more developed their spoken language was, the more complex their gesture use was. Also, Brojde, Ahmed, and Colunga (2012) found that young (24-36 months) bilingual children attend more to eye gaze and pragmatics (social interaction) when learning new words than monolingual children, which may lead to the question of whether bilingual children pay more attention to gestures. Nicoladis (2002) found that the types of gestures used by French-English bilingual children differed depending on what language they were speaking as well as which language was their dominant one. Conventional gestures (which have a specific meaning only within that linguistic system) were used more while speaking English, and the children used iconic and deictic gestures slightly more in their dominant languages.

Facilitating effects of gesture in monolingual language learning tasks

Macedonia & Knösche (2011) found that seeing gesture enhances recall in monolingual adults when learning words in a new language compared to just seeing a picture. This is consistent with Buccino et al.'s (2004) finding that seeing gesture activates mirror neurons in monkeys, but seeing a picture of an action does not. Cameron and Xu (2011) found that preschool-age children recalled more names and actions while retelling a narrative when they were allowed to

gesture compared to children that were not allowed to gesture. Similarly, Stevanoni and Salmon (2005) found that school-age children who were instructed to gesture recalled more correct details verbally while retelling an event than those children who were not instructed to gesture. In studies where children and adults were instructed to act out phrases with actions in them, those who acted out the phrase recalled them better than those who did not (Meklenbräuker, Steffens, Jelenec, & Goergens, 2011; Ratner & Hill, 1991). Recall is aided by gesture production in both children and adults, whether the gestures are spontaneous or encouraged.

Additionally, Goldin-Meadow and Singer (2003) found that gesture mismatches (where the gesture action does not match what is said orally) predict that children are ready to learn a new concept, such as how to solve a math equation (e.g., using two fingers to represent adding two numbers to reach a sum although the two numbers do not actually add up to that sum) (Goldin-Meadow, Cook, & Mitchell, 2009). One explanation for this is that children may try to express motorically what they cannot yet express with speech, a reflection of both cognitive and linguistic development.

Learning a second language with gesture

Kelly et al. (2009) and Tellier (2008) demonstrated that children and adults recall more foreign words when they use a matching gesture (related to word meaning) to learn the word. Tellier (2008) demonstrated these possible benefits of learning with gesture in a study where monolingual French-speaking 4- and 5-year-olds were taught English words—the group that produced gestures

performed better on long-term memorization and production of the words in English than children who just watched the gesture or who were not exposed to the gesture.

Rowe, Silverman and Mullan (2013) concluded that bilingual children remembered novel words better when the words were presented with gestures. However, this study did not require the children to produce the gestures. Learning with gestures one is familiar with (those that are within one's established linguistic system) facilitates learning more than gestures from another linguistic system. Church, Ayman-Nolley and Mahootian (2004) showed that, when presented with an instructional video explaining the concept of conservation of water, English-speaking first graders learned the most from the condition where the experiment was explained with gesture (91%), followed by their English-speaking peers who were not exposed to gesture (53%). The Spanish-English bilingual participants learned far less than the monolingual English children exposed to gesture (50%), but those in the gesture condition learned more than their peers who were not exposed to gesture (20%). This phenomenon suggests that children learn with gesture best when it accompanies of their primary linguistic system, yet it also shows that gesture helps in comprehension of a topic even if the individual does not understand the spoken aspect of language.

As bilingual children learn multiple languages, they must become familiar with the gestures in each linguistic system. Since each language does not usually develop at the same rate as the other (i.e., a Spanish-English bilingual child may be more advanced in Spanish than in English), gesture in each of those languages

may develop differentially as a function of the child's linguistic system. Learning language for multilingual children is thus a different challenge than it is for monolingual children because they may need to differentiate between separate rules and conventions for components of language such as the combination of speech sounds, grammatical and linguistic rules, and gestures as they develop each language they are being exposed to.

Research question

Does producing a gesture while saying a word help bilingual children learn new words faster than just repeating the words? As mentioned previously, Tellier (2008) demonstrated that French monolingual children (with no previous exposure to English) memorized more English words when they were instructed to reproduce gestures while saying the words than children who simply repeated the words while seeing a picture. Her study addressed the effects of teaching with gesture in a weekly class and using commonly known words for preschoolers. The children in both groups recalled the same number of words in a passive vocabulary test, but when asked to produce the words, the group that gestured recalled significantly more than the group that viewed pictures. This provides support for the hypothesis that gesture production will help bilingual children learn new words as well.

The current study examined the effect of gesture production on word learning in preschool children who are developing English along with another language. Unlike Tellier's study, the words chosen were science vocabulary words from first-grade curricula. These were chosen to reduce the likelihood of

the child already having the words in their vocabularies. Although the children in this study were similar in age to Tellier's, this study used a single-subject design so that direct comparisons of two different teaching methods could be made within each child.

Method

Participants

Participants were recruited through the Syracuse University Daycare, based on teacher recommendations and parent interest. The daycare serves employees and students of the university, so the children there have a variety of cultural and linguistic backgrounds. Classroom activities are conducted entirely in English. The Syracuse University Institutional Review Board approved all protocols.

S01. The first participant, S01, was a Turkish-English bilingual female 5;1 years of age. Her primary language is Turkish, and she began learning English at 3 years of age. Turkish is the predominant language spoken at home, although two of her older siblings speak English with her.

S02. The second participant, S02, was a Nepali-English bilingual male 4;6 years of age. His primary language is Nepali, and he began learning English between 1 and 2 years of age. Nepali is the predominant language spoken at home.

For the purposes of this study, each participant was classified as a bilingual individual because each of them was able to produce complete and meaningful utterances in each language and used each language on a daily basis.

Both participants were assumed to be typically developing in all other aspects of development based on their performance during activities and based on discussions with parents and teachers. S01 has corrective lenses, and they were worn each day.

Eligibility

The researcher briefly assessed each child's vocabulary by asking them to name common objects and also determined each child's ability to participate in the task (imitating a gesture and saying a word) during this activity.

Assessment of language skills

Two instruments were used to gather information about the children's language abilities: the *Peabody Picture Vocabulary Test, Fourth Edition* (*PPVT-4*) and a combined version of the *MacArthur-Bates Communicative Development Inventory* (*MCDI*) and the *MacArthur-Bates Communicative Development Inventory III* (*MCDI III*). Since these are standardized assessment tools normed on monolingual English children, it is not appropriate to use normative data, so only raw scores were examined. The parents of each child were given the expressive vocabulary checklists of the *MCDI* and *MCDI III*. Parents were asked to indicate whether each child used each word in L1, L2, or both, giving the researcher information about comparative vocabulary size and abilities. S01's partially completed the word inventory, but the information provided indicated that she knew most of the vocabulary words in both language, with only a few instances where she knew a word only in Turkish or only in English. S02's

parents indicated that he knew almost all of the English words listed and less than half of those words in Nepali. This discrepancy appears contradictory to the fact that they reported his primary language to be Nepali and that only Nepali is spoken at home and may be due in part to the differences in translation or frequency of occurrence between the two. His mother also stated that he had recently begun to prefer speaking in English, so the words she marked down may not be a representative sample of his expressive vocabulary in Nepali.

S01 received a raw score of 91 on the *PPVT-4*, which is a measure of receptive vocabulary in English (what a person understands). For each word, the child is asked to point to a corresponding picture out of a choice of 4. This score is one that is within the range that is achieved by 5 – 6 year old monolingual children. S02 received a raw score of 58 on the PPVT-4, which is a score that is within the range that is typically achieved by 3-4 year old children.

Design

The current study used an alternating treatments single subject design, replicated over 2 children in order to examine the effects of gesture production on language learning. The alternating treatments design allowed comparison of word learning with simultaneous gesture production and word learning without gesture production.

Stimuli

Vocabulary. The researcher selected a pool of object words from kindergarten and early elementary science vocabulary (such as “meadow” and “tadpole”). The pool was then reduced to meet the criteria that they contained no

more than two syllables and could be enacted through gesture. These words were used because they were less likely to be known to preschoolers (words had to be novel to the children) but may have been useful for the child in the future (see Appendix B for a list of target words).

Object words were chosen because they had higher "imageability" and could therefore be more easily recognized by children and could be more easily represented with specific hand gestures (Masterson, Druks, & Gallienne, 2008). Imageability is "the ease with which a concept evokes a mental image" (McDonough, Song, Hirsh-Pasek, Golinkoff, & Lannon, 2011, p. 182). Having words with associated mental images was especially important in order to pair them with iconic gestures (which show meaning) that represented that idea. Studies such as those performed by Masterson et al. (2008) clearly show that typically developing preschool-age children are capable of picture naming tasks; thus, the researcher decided that naming pictures was an appropriate method to assess vocabulary learning.

In order to determine the final list of words, during an initial screening session, the researcher asked each child to label the black-and-white pictures of these words on an iPad. From the labeling activity, each child was assigned a list of 10 object words for which they had given either an incorrect or no response. Each child received the same list of words, but those words were randomly assigned to each condition for each child (see Appendix B for a list of words assigned to each child), resulting in 5 words per condition.

Pictures. The researcher created 20 black-and-white pictures of the object vocabulary words in order to provide consistency across each picture so that the visual stimuli would not have an effect on the way words were learned. Distinct gestures for each picture were chosen and compared to make sure that they were not too similar. (See Appendix C for a list of pictures, words, and associated gestures.)

Procedures

Sessions. The children were seen individually in a separate room at the childcare center 3 times a week for approximately 10 minutes over a period of 6 weeks (including baseline testing). S01 completed 14 sessions, and S02 completed 16 sessions. This discrepancy is due to absences caused by illness. A follow-up session for object words was conducted two weeks after stopping treatment.

Training of task. Each child was first given practice trials in which they were taught to repeat words and also repeat words with simultaneous gestures. These practice trials used generally known objects and actions. During these sessions, the researcher verbally prompted each child to repeat the word or word and gesture after her. After a few trials, it was no longer necessary to prompt the children.

Establishing baseline. First, the researcher asked each child to label the pictures of the 10 object words in order to establish a baseline point demonstrating that the children labeled none of the words correctly in each condition. The number of baseline points varied as is common when replicating

treatments over participants, with S01 having 5 baseline points and S02 having 2. Formal baseline phases are not needed in alternating treatments because the experimental design compares the effectiveness of two different treatments, rather than improvement over time.

Vocabulary probes. At the beginning of each session, a probe was conducted with the 10 target object words to determine the children's memory of the words from the prior sessions. Approximations of the target words were accepted if the child had difficulty with pronunciation. The child's score on each probe was the number of words correct out of 5 for each condition. Responses were video- and audio-recorded and were documented after completion of each session (see Appendix D for a record of correct responses per session).

Instructional sessions. Once baseline was established, instructional sessions began. Target object words were randomly assigned to each condition (see Appendix B for a complete list of target words and gestures). For target words without gesture, the researcher showed the child a picture of the target object on an iPad, said a sentence that helped the child understand what the word meant, and said the word. For target words with gesture, the researcher showed the child a picture of the target object on the iPad, said a sentence that helped the child understand the word's meaning and said the word, accompanied by a gesture. In each condition, the children were required to repeat the word or word plus gesture, respectively.

The order of presentation of conditions was counterbalanced across sessions; if the conditions were ordered Speech Only (SO), then Speech + Gesture

(S+G) in the previous session, then the researcher presented the S+G, then SO conditions for the next session.

Addition to procedures. During the first 7 treatment sessions, the researcher found it difficult to elicit target words during probes since the children did not appear to understand that the researcher wanted them to say the new target word instead of what they thought the pictures represented. Thus, during the 8th session, the researcher implemented an addition to the training procedure. After conducting the probe and teaching both conditions, the researcher presented the target words in the same order they had just been taught and asked the child to label them (just as in the probes). If the child labeled the picture with the correct target word, the researcher affirmed that it was correct and repeated the word. If the child did not respond or labeled the picture incorrectly, the researcher corrected the child and said the target word once (or said the target word with a gesture for the S+G condition). A full description of the sessions appears in Appendix A. This change did increase the number of times each child heard and said the word, which seemed to increase rate of learning. However, these changes were consistent across conditions, so neither condition was put at an advantage due to the changes.

Each participant was given verbal praise during the teaching trials. During breaks between blocks, children were given sticker puzzles or crayons for drawing. Small gifts were given to the children at the completion of the study, and a check for $30 was given to their parents.

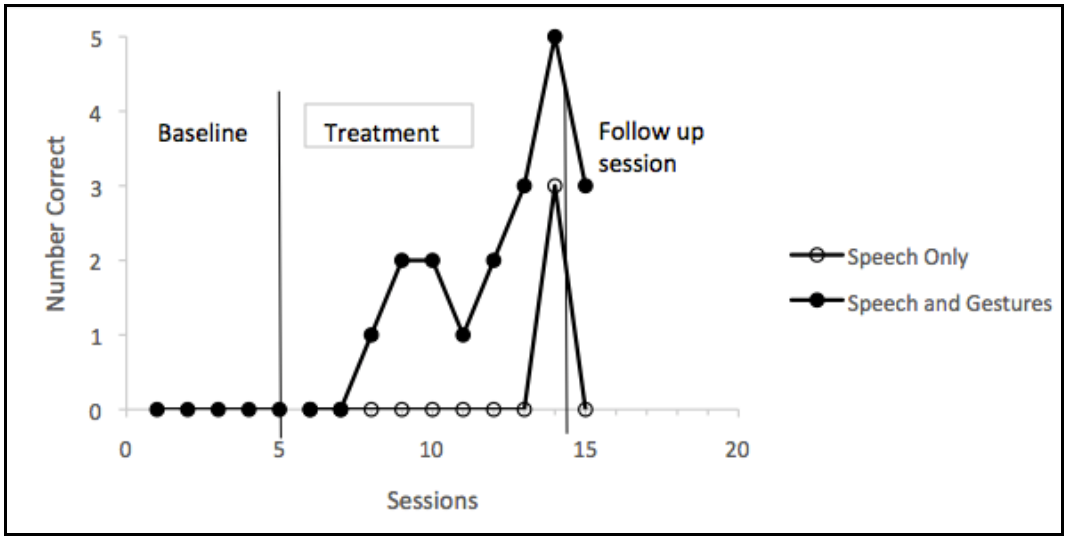
Inter-rater reliability. An independent rater scored probe responses as correct or incorrect for each child from three randomly selected intervention sessions. Percent agreement was 100% between the researcher and the rater.

Treatment fidelity. The researcher completed a practice session before beginning treatment to ensure consistency across conditions and across participants. During most sessions, a second researcher was present to monitor the consistency of probes and treatment procedures. Additionally, an independent rater watched videos of three treatment sessions for each child and completed a checklist indicating whether the researcher had completed the appropriate steps in each condition per each session. The rater evaluated the treatment as complying between 96-100% with the checklist; in one session the researcher did not remember to repeat the gesture during the additional procedure, which was likely due to that session being the first where the new procedure was implemented.

Results

In order to answer the question of whether or not gesture production speeds children's learning of new words, this study compared words modeled and then produced by the child with speech only or with speech and gesture. The effects of treatment can be seen in Figures 1 and 2. These figures illustrate the number of words each child produced correctly in each condition during baseline and during probes at the beginning of each teaching session, as well as in follow up sessions.

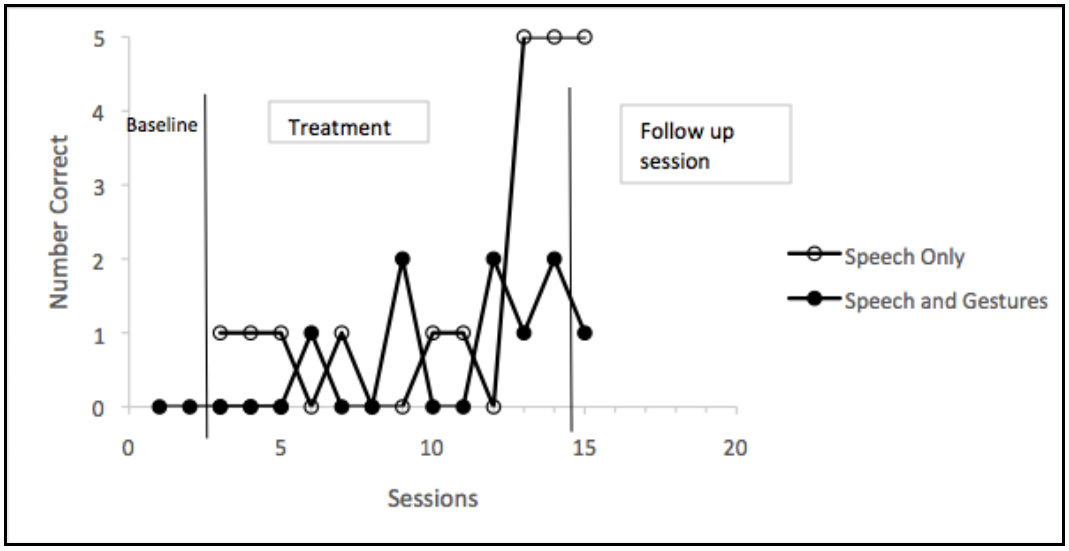
Figure 1: Number of words produced correctly in each condition per session, S01



S01

S01 produced 5 out of 5 target object words in the S+G condition, while only producing 3 out of 5 in the SO condition in the final treatment session. In the follow up session (conducted after two weeks), she produced 3 out of 5 S+G words and 0 out of 5 SO words. Viewing the data points across sessions reveals that she consistently produced some S+G words correctly after beginning treatment, but she only recalled SO target words in the final treatment session (see Appendix D for a complete list of which words were correctly produced). Visual inspection of data (a standard analysis in single-subject designs) supports the hypothesis that speech plus gesture production facilitated vocabulary learning for her more than just learning through verbal repetition.

Figure 2: Number of words produced correctly in each condition per session, S02



S02

S02 produced 5 out of 5 SO words and only 2 out of 5 S+G words by the end of treatment with object words. In the follow up session, he correctly produced 5 out of 5 SO words and 1 out of 5 S+G words. However, the graph of his correct productions reveals variability across sessions; some days he only correctly labeled SO words and some days he only correctly labeled S+G words. S02 remembered more SO words in the final three probes, his irregular performance in previous probes does not appear to indicate an effect for either condition.

Discussion

It appears that gesture production had a positive effect on learning for S01; her success and consistency in learning object words seems to affirmatively answer the first research question. However, gesture production did not appear to have a positive effect on word learning for S02, demonstrated by the high degree

of variability of his responses during probe and his performance in the follow up session. However, it should be noted that he did not exhibit consistent responses until the last two sessions plus the follow up session. Results sometimes differ for participants in studies with a single subject design because the design reveals individual differences particular to each participant. Since this study has only been replicated over two participants, it is not yet possible to draw a firm conclusion about the effects of gesture production on word learning. Yet, it did have a clear positive effect for S01, indicating that gesture may help some children in vocabulary acquisition. Some possible reasons for the differences in learning between the two participants are addressed below.

Word effect

Object words were assigned randomly to each condition for each participant. Both children learned two words more quickly than the other target words: “forest” and “puddle”. Learning of “forest” may be explained by the fact that it is more frequently heard in conversation than some of the other target words; additionally, it appears regularly in storybooks that the children may have been exposed to. The gesture for “puddle” was connected to an action (“You can splash in a puddle.”), and so that may have promoted faster learning than the more descriptive gestures for other target words (such as wings for a “falcon”). “Puddle” was in the S+G condition for both participants, and “forest” was in the S+G condition for S01 and in the SO condition for S02.

Also, it is possible that the target word was competing with another word that the child already had a mental representation for, making it more difficult to

remember the target word. For instance, “bird” and “rock” most likely have strong representation in children’s vocabularies because they are used often. This was observed during probes when the children consistently labeled the stimulus for “falcon” as “bird” and the stimulus for “boulder” as “rocks.” Children learn basic-level words such as “bird” and “rocks” more easily than related superordinate words (e.g., “animal” or “nature”) or subordinate words (e.g., “falcon” or “boulder”), and they appear to be hesitant to learn more than one word for a single item (Gelman, Wilcox, & Clark, 1989). This may have affected how easily the children could recall the target words as opposed to other words they already knew.

Phonological differences between the words (more or less challenging sounds and sound combinations) did not appear to have an effect on which words were learned. One-syllable words (“ramp” and “net”) were actually learned later than other two-syllable words with more difficult sound combinations (such as “puddle”).

Effect of visual stimuli

The stimuli were black-and-white line drawings, which may have made it harder for the children to understand what they represented. For instance, one participant often labeled the stimulus for “windmill” as “pinwheel”. This is why the researcher deemed it necessary to present the words with contextual sentences. When this did not provide a sufficient cue for children, the experimenter provided corrective feedback when the child used the word (e.g., pinwheel) and said, “No, my word is windmill,” and asked the child to repeat the target word. Closer

inspection of the words learned in each session (Appendix D) reveals that both participants recalled “boulder” and “falcon” either once or not at all.

Level of motor development

Though the motor skills of the children were not formally assessed, the researcher observed differences in the neuromotor skills between the two children. During the initial screening session, S01 could imitate gestures with finer motor movements, such as wiggling her fingers. However, S02 did not imitate fine motor movements and also used his whole body when attempting to imitate hand gestures. Therefore, the researcher modified gestures for S02 so that they incorporated upper body movement instead of just hand movements, yet S02 still displayed some difficulty while imitating the gestures. This may explain why he learned the SO words faster; cognitive demand of producing a simultaneous gesture may have been greater than just repetition.

Level of language development

As indicated in the methods section, the children’s vocabularies in English differed, with S01 demonstrating a larger English vocabulary. In addition, observation revealed that her English syntax was at a higher level than S02’s.

These differing levels of development may have had an effect on each child’s learning of the words; since S01 was at a higher level, a word-learning task may simply have been easier for her. In addition, Ratner (1991) demonstrated a clear development effect in a comparison of learning with gesture between first graders, fourth graders and college students. She demonstrated that first graders did not recall phrases as well as the fourth graders or college students. This

suggests that older children may learn better with gestures, although it did not address learning in preschool-age children.

Personality and interpersonal interaction

The two children also differed in the way they interacted with the researcher during sessions. S01 was much more outgoing and spoke much more during treatment activities. S02 did not interact as willingly with the researcher during initial sessions, and even by the end of treatment sessions, he did not speak much during the treatment activities. The children's inclination to learn with gesture may also have been affected by their tendencies to use or not use gesture in everyday conversation, based on how they interacted with peers, teachers and family.

Implications for Further Research

Level of development

There was a 7-month discrepancy in age between the two participants, which is not typically a large difference, but it may be significant in that they appeared to be at different levels of neuromotor and language development. This makes sense because children quickly grow physically and cognitively in the early years of childhood. In future research, collecting more information about motor and language skills may give more insight into the ages or levels of development where teaching with gesture may be most beneficial, or it may indicate that age and developmental level are not factors in learning with gesture.

Cultural and linguistic differences

There are differences between English gesture development and gesture development in both Nepali and Turkish, some of which may be due to the different ways in which those languages develop; for instance, Turkish children begin to use iconic gestures early on to represent actions because they begin to use utterances with many verbs, as opposed to English-speaking children, who tend to use more nouns and prepositions when speaking and use more pointing gestures early on (Dasen et al., 2009; Furman, Küntay, & Özyürek, 2014). Therefore, the gestures used in this study may have been culturally biased because they were created by an English speaker and were attached to object (noun) words. In future replications of this study, it may be appropriate to examine typical gesture use and development in each child's native language and how that may have a cross-linguistic influence on how those children use gesture to learn.

Learning style

Different people learn better with different techniques. The discrepancy in learning between S01 and S02 suggests that S01 may be more of a visual and kinesthetic learner, whereas S02 may be more of an auditory learner. Thus, it may be beneficial to employ different methods of comparing the two conditions of speech production versus speech and gesture production in an individual, such as examining the effect of just speech production, then adding gesture production to determine the differences in learning within that individual based on how he or she seems to learn best. It is possible that learning with gestures may be most beneficial to those learners who already engage in kinesthetic learning. This could

be related to the frequency of gesture use of that individual and those who provide input, such as family members and caregivers. Neither child in this study was assessed for his or her learning style, and so it will be important to include that variable in future research.

Conclusion

Since most teaching and speech therapy methods are based on knowledge of monolingual children's development, the limitations they place on educational professionals' abilities to teach bilingual children to communicate may be remedied by developing new techniques to promote learning. In consideration of the results obtained in this study, it appears that simultaneous oral and gestural production of words should be investigated further as it may facilitate learning in some children.

In conducting future research, differences in culture, language development in L1 and L2, neuromotor skills, interactional style at home and in school, and personality may help to account for the individual differences seen in the study.

The next stages of this line of research will include replication across more children, examination of actions as well as objects, and consideration of other types of vocabulary words, level of motor skill, and type of learning style. Furthermore, providing a richer context than one sentence may enhance learning with gestures, as prior studies have demonstrated a positive effect of gestures in children's memory for narratives. The current findings do suggest that pursuit of this line of research would be fruitful.

Appendix A:

Outline of teaching procedures during each session.

Note: The researcher changed procedures on 2/27, during the 8th treatment session, due to difficulties eliciting target words during probes. The additional procedures in the teaching session helped the researcher emphasize the recall of new words instead of other labels the children had for each picture.

Speech condition:

-Researcher presents picture/video and says contextual sentence once.

-Researcher says target word once, using consistent emphasis on words across conditions. For target action words, the researcher plays the video again while saying word.

-Child repeats target word, prompted by researcher if necessary. If the child does not say the word, the researcher attempts to elicit target word but does not say target word again.

----------Up to and including 2/25----------

2/27 on:

-After going through the above activities, researcher goes back through pictures in the same order as presentation and asks, "What is this?" (if the child does not say the word right away).

-If child is correct, researcher affirms correct word and says target word once.

-If child does not say target word, researcher says, “That’s not my word. My word is [word].” (only says word once)

Speech + Gesture condition:

-Researcher presents picture/video and says contextual sentence once.

-Researcher says target word once, simultaneously producing a gesture and using consistent emphasis on words across conditions. For target action words, the researcher plays the video again while saying word and performing the gesture.

----------Up to and including 2/25----------

2/27 on:

-After going through the above activities, researcher goes back through pictures in the same order as presentation and asks, “What is this?” (if the child does not say the word right away).

-If child is correct, researcher affirms correct word and says target word once with simultaneous gesture.

-If child does not say target word, researcher says, “That’s not my word. My word is [word + simultaneous gesture].” (only says word + gesture once).

Appendix B:

Target words and corresponding sentences for each participant.

Gestures indicated in italics.

S01

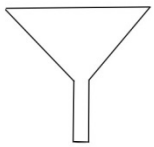
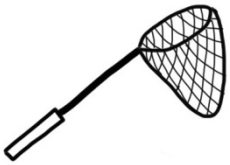
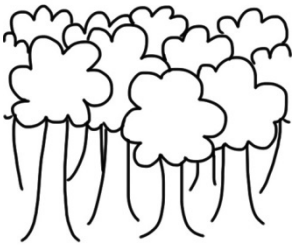
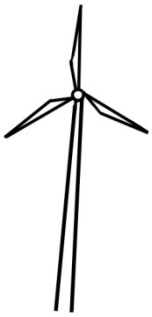
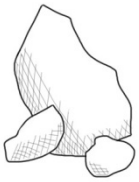
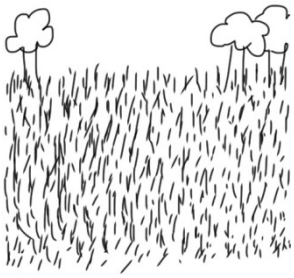
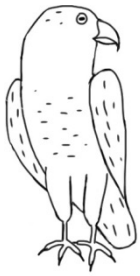
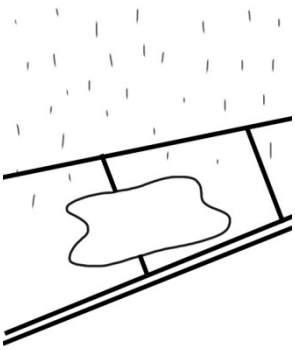
Object Words	
Speech	
falcon	A falcon is a kind of bird.
tadpole	A tadpole is a baby frog.
net	You can catch things with a net.
boulder	A boulder is a big rock.
funnel	A funnel is used for pouring water.
Speech + Gesture	
forest	A forest has lots of trees in it. *(forearms held together with hands rounded to form tree, repeat 3 times)*
puddle	You can splash in a puddle. *(right hand hits down as if splashing)*
windmill	A windmill goes around in the wind. *(left forearm held perpendicular to ground with a fist, right fingers extended and move right hand in a circular motion in front of the fist)*
meadow	A meadow has lots of grass. *(hold hands facing each other with fingers extended and move arms back and forth)*
ramp	You can go up a ramp. *(one arm held at diagonal, other hand moves from the elbow to wrist, simulating going up)*

S02

Object Words	
Speech	
net	You can catch things with a net.
tadpole	A tadpole is a baby frog.
funnel	A funnel is used for pouring water.
forest	A forest has lots of trees in it.
windmill	A windmill goes around in the wind.
Speech + Gesture	
meadow	A meadow has lots of grass. (hold hands facing each other with fingers extended and move arms back and forth)
falcon	A falcon is a kind of bird. (hold hands to shoulders like wings)
ramp	You can go up a ramp. (one arm held at diagonal, other hand moves from the elbow to wrist, simulating going up)
boulder	A boulder is a big rock. (one hand held above the other as if grasping a big rock)
puddle	You can splash in a puddle. (right hand and arm hit down as if splashing)

Appendix C:

Object word pictures

			
funnel	net	forest	windmill
			
tadpole	boulder	meadow	ramp
			
falcon	puddle		

Appendix D:

Words produced correctly in each probe

S01 Object words

Date	**Speech**					**Speech + Gesture**				
	boulder	funnel	net	tadpole	falcon	meadow	ramp	windmill	puddle	forest
10-Feb										
11-Feb										
13-Feb										x
17-Feb									x puddles	x
18-Feb									x	x
20-Feb										x
24-Feb									puddle and rain	x
27-Feb						meadl-grass		x	puddle-rain	x
6-Mar	bould			x	x	x	x with gesture	x	x	x
20-Mar							x		x	x

S02 Object Words

Date	Speech					Speech + Gesture				
	net	windmill	funnel	tadpole	forest	meadow	puddle	ramp	falcon	boulder
11-Feb										
13-Feb										
17-Feb		winill								
18-Feb					foret		Not counted (towel)			
20-Feb					x		Not counted (towel)			
24-Feb		x winill								
25-Feb					x					
27-Feb			funesh							
3-Mar							x			x
4-Mar	x	x	x	x	x		x			
6-Mar	x	x	x	x	x	x	x			
20-Mar	x	x	x	x	x	x				

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