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DEVELOPMENTAL DIFFERENCES IN MATHEMATICAL LEARNING AIDED BY EMBODIMENT THROUGH GESTURE

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Abstract

Math education is an important part of American education; however, American children seem to be falling short of their foreign peers. Recent studies such as that of Goldin-Meadow, Cook and Mitchell (2009), have shown that gesture can improve math performance. This study investigates how gesture affects math performance across developmental stages. Participants were exposed to pre- and post-testing with one of three conditions: gesture, partial gesture, and no gesture. It was anticipated that students in the gesturing condition would show the greatest improvement on performance; however, it was found that when verbal instruction was added, the gesturing had no effect on the participants' math performance. This study suggests that teachers should examine multiple methods of teaching because everyone can learn.

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Developmental Differences in Mathematical Learning Aided by Embodiment through Gesture

When asked the cost of ten coconuts, a Brazilian boy was able to come to the correct answer based on the price of one coconut. Some may say he had a good math teacher; however, this boy was from the streets of Brazil and had never attended school. His ability to price out coconuts correctly was a survival skill he had acquired in order to care for himself (Nunes, Schliemann, & Carraher, 1993).

Embodiment and Math

The survival skill of taking mental representations and linking them to the physical world through the use of the body, or the use of embodiment, can be seen throughout all cultures and species of animals (Lakoff & Johnson, 1999). In many cultures “digits” can be referred to as fingers and toes as well as numbers, letting physical body parts link the mental representations of numbers (Lancy, 1983). The Yupno culture is found to extend this linkage of body parts and numbers to many other body extremities such as the penis, which is considered “thirty-three” in their numbering system (Ward, 2006). In Kilenge, body parts are considered bases of counting where five is the hand, ten is two hands, and twenty is the entire body. This culture combines the extremities and the body to create thirty (Ward, 2006). The common tendency of using body parts for counting has a brain-based explanation. Gerstman (1940) found that when the left parietal lobe is damaged it not only produces the inability to understand numbers but also produces the inability to identify fingers by touch. While there are strong arguments that state the two instances are dissociated from one another, this information still suggests that there is a strong evolutionary relationship between numbers and body parts (Ward, 2006).

There is also support in the theory of embodiment theory in the research of learning language. Andres et al. (2008) stated that imaging tasks gives the ability to embody the word for increased comprehension. Davoli et al. (2009) stated that imagining that action will have an effect on the learner's final performance in the task. Fischer et al. (2008) showed that we, in fact, mentally simulate behaviors as a way of understanding the behavior of others. Neidenthal (2007) agreed that language comprehension relies in part on embodied conceptualizations of the situations being described. These embodied conceptualizations, such as gestures are thought to disambiguate language through engaging multiple parts of the brain (Kelly, Barr, Church, & Lynch, 1999). Even the blind are found to use gesture, suggesting that speech and gesture are embodied (Iverson & Goldin-Meadow, 1998).

Butterworth (1999) built on these concepts and showed a strong relationship between the body, language and math in his model of math representation in the brain (Ward, 2006). He suggested that the model of math comprehension in the brain has multiple paths. These paths consisted of direct transcoding of numbers, the language processing of the math perception, and the route between numeral recognition and math semantics all linking to the action systems that the motor system carry out (Ward, 2006). Butterworth's (1999) model can be seen below.

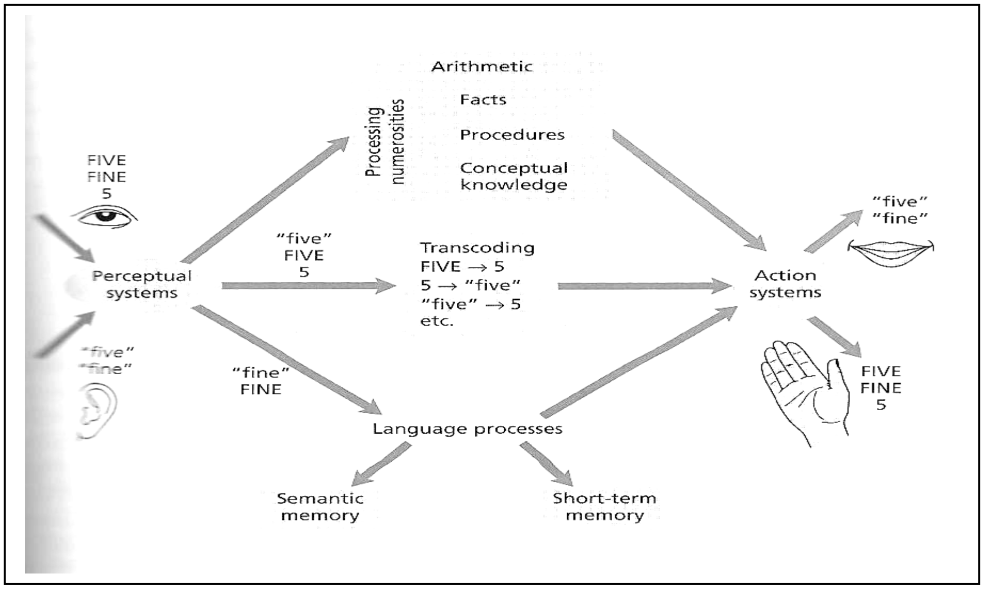

Figure 1. Butterworth's model presented in *The Student's Guide to Cognitive Neuroscience* (Ward, 2006), p. 277.

Butterworth's (1999) model suggests that the brain uses multiple pathways to reach the correct answer in math. Understanding the usage of multiple pathways as systems of checks and balances for solving math computations, an additional pathway is suggested as an aid in computing math problems. One possible additional pathway is the use of gesture. The use of gesture as an additional pathway to the action systems could aid the three standing pathways, in that it already engages the motor cortex of the brain which is used in the final stages or the action systems.

Current Math Educational Practices

Math and science education has long been a topic of discussion in the United States. The reason is the increasing gap between American students and foreign students' math performance. There has been little change in decreasing this gap according to the Trends in International Mathematics and Science Study (TIMMS) which studied American fourth graders between 1995 and 2003 (Newcombe, et al., 2009). This is quite alarming as the global economy continues to grow, leaving American students behind in mathematics and science.

The problem in math education seems to occur between grades four and twelve. This is when American students slowly begin to differ from their foreign counterparts (Education World, 2002). There is a call for reformation to solve this problem. Many parents are beginning to take a stance on how American children should be educated. Some parents feel that the traditional memorization practices of math should be brought back while others feel that an inquiry-based math education system is the answer (Education World, 2002).

The Department of Education has decided to take action by proposing multiple solutions to counteract the deficit in math education (United States Department of Education, 2010). The Department of Education recently released new standards which include but are not limited to kindergarteners learning to count to 100, second graders learning to subtract and add triple digits, and third graders learning fractions (United States Department of Education, 2010). The National Mathematics Advisory Panel suggested ways to achieve these standards leading up to the final decision of instating them. The suggestion of the panel was that,

> "Our citizens and their educational leadership should recognize mathematically knowledgeable classroom teachers as having a central role in mathematics education and should encourage rigorously evaluated initiatives for attracting and appropriately preparing prospective teachers, and for evaluating and retaining effective teachers (United States Department of Education, 2010)"

The panel suggested that in order to create effective teachers, those teachers should be trained with the most recently researched methods of learning shown to be effective with students. These teachers are encouraged to be educated continuously on the latest methods of learning (United States Department of Education, 2010).

Currently teachers are encouraged to take the concepts of grouping that are found in addition and multiplication and apply them to the physical world through the use of manipulatives. For example, the grouping and counting of apples is encouraged as a teaching tool to show simple addition (Beckmann, 2008). The grouping of different colored dots and physical world object such as different types of drink and food is suggested as a means of teaching multiplication and complex addition such as the associative and communicative property of addition (Beckmann, 2008). The use of these manipluatives is a current practice in math education that links the physical world to the mental representation of numbers that we have in the brain.

While the manipulatives used in current practices are physical objects in the world, the theory of embodiment is an alternative suggestion for teachers. Key concepts of mathematical learning could be illustrated by the use of gesture. The use of fingers or "digits" may be able to link the arbitrary meaning of numbers to their physical representation.

The Connection Between Gesture and Learning

Current research supports the use of gesture and mathematical understanding. Gesture shows its benefits to users in multiple ways which would explain its usage by all cultures and all age groups (Goldin-Meadow, et al., 2001) Gesture conveys information through a visio-spatial format using an additional portion of the brain to the language portion which is commonly used in mathematics (Singer & Goldin-Meadow, 2005 & Goldin-Meadow, et. al, 2001). This usage of multiple pathways of the brain may act to reduce the cognitive load when performing a task (Goldin-Meadow, et al., 2001).

When looking at the aspects of this evolutionary language, Reynolds and Reeve (2002) argue that gesture maintains student's attention and allows the student to communicate to a teacher what they already know through symbolic communication. This may occur because gesture aids in lexical access. This was shown by examining students' explanations and their use of hesitations, speed, and hand movements during speech (Krauss, 1998). This applies to untrained adults and children. Untrained adults could actually recognize children's use of gesture as a means of showing their basic understanding. The adults were then, in turn, able to aid the children in gaining a greater understanding of the topic (Goldin-Meadow, Wein, & Chang, 1992; Goldin-Meadow & Sandhofer, 1999). This suggests that gesture can be used as an additional learning tool for teachers to work with students.

Looking at math education directly, Goldin-Meadow, Cook, & Mitchell's (2008) work with gesture showed that students using the gesture of moving their entire hand under the math problem in which they were being taught, they were able to retain the math lesson better. Goldin-Meadow et al. explained the use of gesture as an enhancement in math performance by saying that gesture not only reflects understanding but also activates the motor cortex as well as the language cortex (Goldin-Meadow, 2000). This activation in not one but two very well-connected entities of the brain is what enhances the child's ability to retain novel information.

The activation of multiple areas in the brain, gives the student an additional pathway to the verbal instruction allowing the student to better learn a novel task. It was found that when the gesture is complemented the verbal methodology of the math problem, but did not simply repeat the speech being taught, the learner performed better on post-tests (Goldin-Meadow & Singer, 1999). In a natural setting this was found to occur 40% of the time, giving the learner 40% of the problem solving strategies through gesture (Goldin-Meadow, Kim, & Singer, 1999).

In a follow-up study students who were taught to perform the correct gesture sequencing of the v-shaped hand, which signified grouping, scored higher on a post-test than those who were taught the same lesson without gestures, or those taught with the partially correct gestures where the v-shape did not show the correct grouping of the numbers (Goldin-Meadow, et al., 2009). These findings suggest that the use of gesture was able to activate additional processes in the brain to computing math problems, possibly enhancing their ability to achieve a correct response.

The Current Study

While Goldin-Meadow et al. (2009) was able to see the use of gesture as an additional pathway to computing math, they tested only 9-10 year old children with the associative and communicative properties of addition. I examined multiple ages of children and multiple forms of mathematics.

To better define the children used in Goldin-Meadow et al.'s (2009) study, they can be considered to be in Piaget's concrete developmental stage (Poole, Warren, & Nunez 2007). These stages are a commonly used measure of cognitive development, which would coincide with a student's ability to compute mathematics due to its focus on ability to conserve groupings and abstract thinking (Poole, Warren, & Nunez 2007). The Piagetian stages of development are the sensori-motor stage which is marked by the child learning they are different than the environment that surrounds them; the pre-operational developmental stage which is marked by the ability to use language to symbolize meaning; the concrete developmental stage which is marked by the child's ability to begin abstract thinking; and finally, the formal operations stage which is marked by the child's ability to think without concrete objects or mentally simulate the physical world (Poole, Warren, & Nunez 2007). In this study, I examined multiple ages of children, in three (Pre-Operational, Concrete, & Formal) of the Piaget's four stages of development. These three stages were chosen based on the child's ability to use mathematical symbols to give meaning to math computations.

Multiple types of mathematics were be examined in the present study including basic addition, the associative and communicative property of addition, single variable algebraic expressions, and the FOIL method or extended distributive property of multiplication.

It was hypothesized that the use of embodied gesture, in contrast to no gesture and attention focusing gesture in the teaching of multiple math concepts would enhance the performance level of participants in all developmental stages. This was hypothesized based on the theory that as developmental stage increases, the ability to think about more manipulatives increases, creating a blanket effect of gesture across math concepts and developmental stages.

An alternative hypothesis was that all developmental stages would not perform the same based on the gesture effect. The children in the pre-operational stage of development may show cognitive over load from multiple representations of a concept at the same time (Poole et al., 2007). Therefore, they may not show an improvement of learning with gesture added to verbal instruction. The formal operations stage do not rely heavily on concrete objects in the physical world for cognitive computation. Therefore, they may not need a physical representation of the world, or the use of gesture, to mentally symbolize the computations of the math problems (Pole, et al., 2007). If this is true, they may show no additional learning when gesture is used (Ward, 2006).

Method

Participants

Participants 4-25 years of age were recruited. This sample was recruited from the Penn State Behrend Early Learning Center, Behrend's Research Participation Pool, and Northeast Elementary School, and word of mouth.

These participants were tested and placed into three independent samples of Piaget's pre-operational stage, concrete operational stage, and formal operational stage. The participants' average age was calculated and coincided with Piaget's suggested age range for each cognitive developmental stage. The number of males and females are broken down by stage of development with the average age of each cognitive stage in Table 1.

Table 1

Participant demographics shown by stage of development.

	Pre-Op	Concrete	Formal	Total
Participants who are female	6	7	9	22
Participants who are male	13	9	6	28
Average age of each stage	6.42	9.87	16.33	10.50

Recruiting

All of the children from the Penn State Behrend Early Learning Center and Northeast Elementary School were recruited via fliers mailed out to the parents. They had a parent or guardian sign a consent form allowing the researchers to work with the child. Upon completion of an informed consent, the children were prompted by the experimenter who explained that the work they do in this experiment will not count toward their school grade but that the experimenter hopes they still work hard in order to know how well they can do. Those children under 18 years of age were then verbally consented. Participants over the age of 18 were asked to sign a consent form. The parents were asked to fill out a background questionnaire of their child's demographics (for example, Gender, SES, etc.). Those participants who were over 18 years of age were recruited from the research participation pool. Upon entering the study, they were asked to read and sign an informed consent and asked to fill out a background questionnaire which was similar to that of the children.

Measures

To determine the participant’s stage of development Piaget’s conservation tasks and metaphor tasks were used. These tasks have been commonly used in determining cognitive ability in past research studies (Poole et al., 2007).

The first test was Piaget’s test of conservation of numbers (Siegler & Alibali, 2005). The test had the experimenter first lay out two groups of seven pennies perfectly aligned. The participants were asked, “Is there the same number or a different number?” The experimenter said, “Now watch what I do,” as they spread out the bottom row of pennies. Once spread, the experimenter asked, “Is there the same number or a different number, why?”

The next test of development was Piaget’s conservation of volume task (Siegler & Alibali, 2005). Two shorter identical cylinders were filled with equal amounts of water and the participants were asked, “Do they have the same amount of water or a different amount?” After the participants responded, the experimenter poured the water from one of the cylinders into a taller skinnier cylinder as they told the participant, “Now watch what I do.” Once poured, the experimenter asked the participant, “Do they have the same amount of water, or a different amount, why?”

The final test of stage development was Piaget’s conservation of mass task which was done with play dough (Siegler & Alibali, 2005). The experimenter placed two pieces of play dough on the table that were of equal size and shape. The participant was asked, “Do they have the same amount of play dough or a different amount?” Once the participant answered, the experimenter then stretched one of the pieces of play dough and told the participant, “Now watch what I do.” Once spread out the experimenter asked the participant, “Do they have the same amount of play dough or a different amount, why?”

The test for formal operations stage of development was completed with a series of proverbs. Participants were asked to tell the experimenter what the proverb, “A rolling stone gathers no moss” meant to them. Participants were also asked to explain: “Better to light a candle than to curse the darkness,” and “An ant may well destroy a dam.” If participants were able to analyze these proverbs at an abstract level and not by their literal meaning, then they were considered in the formal operations stage of development (Siegler & Alibali, 2005). If they were able to examine the sentence beyond the physical objects described and compare the objects to other physical objects not mentioned, they were considered to be able to think abstractly. This showed their ability to take the non-literal meaning of the proverb and in turn be a part of the formal operations stage of development which is set a part from the concrete developmental stage by the ability to think abstractly (Siegler & Alibali, 2005).

The first level of math problems were basic addition problems. These were given with a basic understanding of mathematical symbols and without which was given in pictures. The second level of math problems were the associative and communicative properties of addition. These problems were similar to Goldin-Meadow et al.’s (2009) math problems, to attempt to show a replication of their results. The next level of math problems were simple algebraic expressions. The final level of math problems were the FOIL method. The math stimuli for the pre- and post- test can be seen in Figure 2.

Figure 2. Math stimuli organized by types of mathematics.

Basic Addition with no understanding language:	 +  = ______
Basic Addition with understanding of language:	2 + 4 = ________
Associative and Communicative Property of Addition:	5 + 2 + 3 = ____ + 3
Single Algebraic Expressions:	7x + 7 =21
FOIL Method:	(5X + 3)(9X – 3)= ________

Procedure

Once the demographics were given to the experimenters the participants were given a test to measure their stage of development (pre-operational, concrete, or formal). Each test was repeated three times. Following the procedures described by Seigler and Alibali (2005), if the participant answered 70% or above answers as “different” for the second of the questions they were placed into the pre-operational stage of development. If 70% or above of the answers were “same”, but were unable to answer why, they were placed into the concrete operational stage of development, and were still tested for formal operations stage of development. If the participant was able to also answer why in addition to receiving 70% “same” answers, they were then tested for the formal operations stage of development.

Once placed into their respective developmental stages, they were given a 6-problem pre-test as would be given in a normal classroom. The number of problems chosen was identical to Goldin-Meadow et al.’s (2009) choice of 6 problems for each test.

The pre-test chosen for the participant to start with was decided based on their age level. Those who were 6 years of age or younger were given the simple addition problems, those ranging in age from 6-16 were given the associative and communicative properties of addition, and those 16 and above were given the FOIL method problems to start. The pre-tests were graded for previous knowledge of the topic. If the participants were found to complete the pre-test with 70% accuracy or higher, they were assumed to have had a confounding variable of knowledge of the topic and were given the next level of pre-test. If they were below 70% accuracy on their pre-test, they were assumed to have not had enough previous knowledge of the topic and were allowed to proceed with a lesson on the topic.

Once the pre-test was given, participants were randomly assigned into three conditions of gesture. The first of those conditions was the no-gesture condition. They were given a math problem similar to those on the pre-tests and were taught the words, "I want to make one side equal to the other side," which signifies the answer they are looking for. This is similar to Goldin-Meadow et al.'s (2009) study where their no-gesture condition only had a verbal lesson. The verbal lesson for this study also included an explanation of what numbers were to be grouped. For the basic addition and associative and communicative property of addition, the numbers that needed to be added were signified as the grouped numbers. The numbers to be grouped in the basic algebraic expressions would be those integers that were not related to x. For the FOIL method, the numbers were grouped based on the order in which the numbers needed to be multiplied (first numbers, outer numbers, inner numbers, and last numbers).The second condition was the correct gesture condition. Those who were placed in the correct-gesture condition were taught the same words and were given the same math problem presented to the no gesture condition, but had an additional gesture component. The gesture that they were taught was to point with the v-hand to the numbers that needed to be grouped in order to solve the math problem. Finally, the third condition was the partially correct-gesture condition. In this condition the same verbal instruction was used with the numbers that needed to be grouped, but the gesture was pointing with one finger to draw attention to those numbers.

Participants were able to complete the practice problems and ask questions. If the participant asked a question, the experimenter simply gave the same information that they had previously given in the math lesson. There was no feedback on the participant’s practice problem performance.

After the math lesson was completed, the participants were given a post-test that had similar problems to the pre-test. The problems were graded for accuracy viewing the effect of each condition on their post-test score. The parents and participants were thanked and debriefed with an open question session regarding the study.

Results

Once the post-test was collected, it was graded for percent correct. A 3 (gesture condition) x 3 (developmental stage) x 2 (Pre-Post Accuracy) repeated-measures ANOVA test was conducted. Partial Eta Squared were used as a measure variation within the sample population (Green & Salkind, 2008). The first between-subject independent variable was the conditions of gesture (gesture, no gesture, and partial gesture). The second between-subject quasi-independent variable was the stage of development (pre-operational, concrete operational, and formal operational). The within-subject dependent variable analyzed was the pre- and post-test scores of the math tests. Mean percentage scores for the pre- and post- tests can be seen in Figure 3.

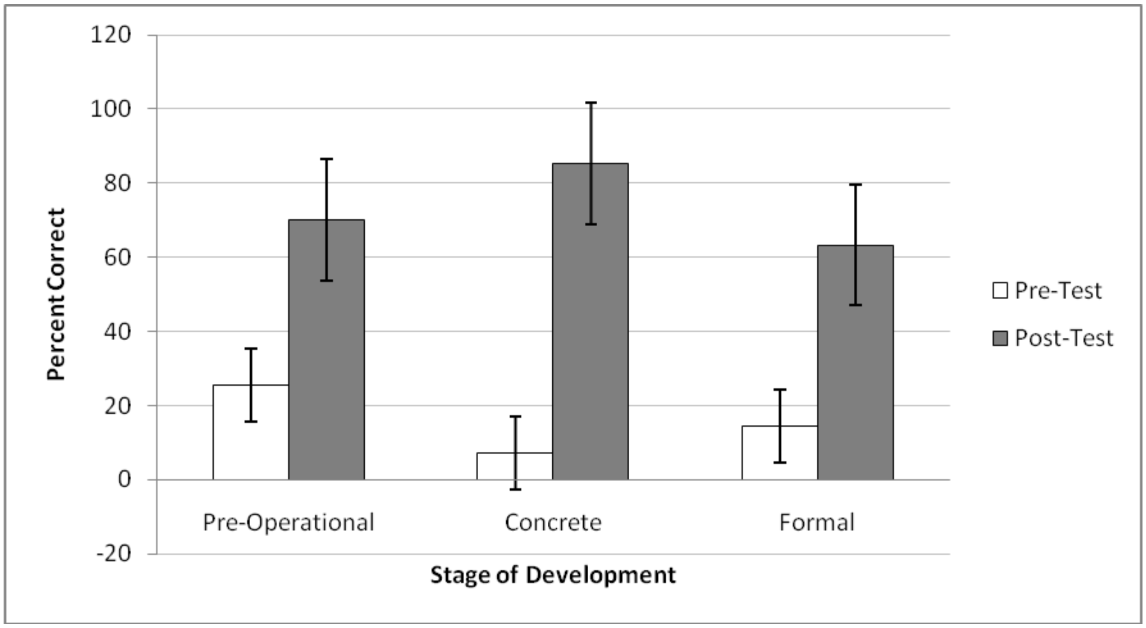

Figure 3. *Mean percentage scores for pre-tests and post-tests by stage of development collapsed across gesture condition.*

A significant difference in pre-post scores was found, F (1, 50) = 102.35, $p <$ .001. In all cases post-test scores were higher. This effect varied by developmental stage as seen in the significant interaction of pre-post by developmental stage, F (1, 50) = 3.60, p <.05. To further understand this interaction, a separate test was performed for each stage of development. The main effect of pre-post was significant for each age group: pre-operational, F (2, 19) = 15.88, p = .00, η^2 = 0.498; concrete operational, F (1, 16) = 113.82, p = .00, η^2 = 0.90; formal operational, F (1, 15) = 27.08, p = .00, η^2 = 0.69. While all developmental stages had significant pre-post test effects, the effect sizes of each suggest that the pre-post effect was strongest for the concrete developmental group. To support these ideas we created a gain score by subtracting pre-test from post-test scores.

The concrete operational group showed the largest gain in learning. There was a significant difference between the pre-operational and concrete operational group, t (33)= -2.48 , p=.019 and between the concrete and formal operational group, t (29)=2.502 , p= .018. There was not a significant difference between the pre-operational and formal group, t (32)=-2.89 , p=.774.

There was no significant main effect of gesture F (2, 50) = 1.38, $p > .05$, nor was there a significant interaction of gesture with pre-post tests scores, F (2, 50) = .49, p = .62. The three-way interaction of gesture by pre-post test by developmental stage was also not significant, F (2, 50) = 0.34, $p > .05$. Mean percentage correct for the pre- and post-tests by condition of gesture can be seen in Figure 4.

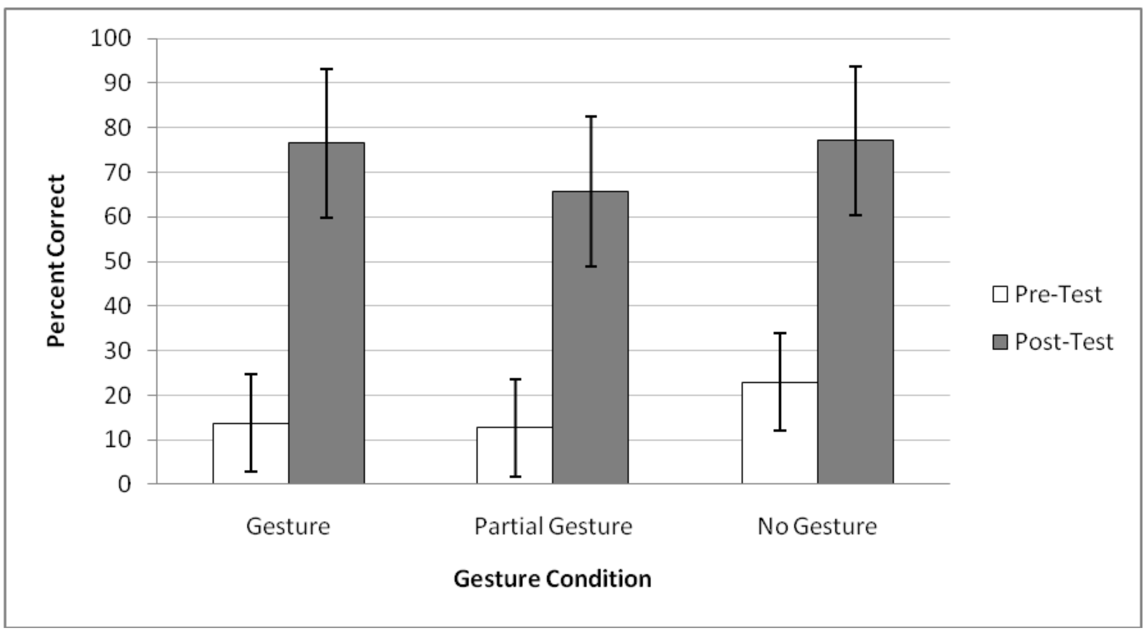

Figure 4. *Mean percentage scores for pre-tests and post-tests by condition of gesture.*

Discussion

The use of gesture during mathematical teachings in the present study did not have an effect on any of the developmental stages learning. This finding is different than that of Goldin-Meadow et al.'s (2009), where 9 and 10 year-old children were taught to use gesture and in turn improved performance (Goldin-Meadow, et al., 2009). Analyzing the method carefully revealed subtle differences between the two studies. The children in her study were forced to use the gesturing strategy while completing their post-test (Goldin-Meadow, et al., 2009). The children in the present study were taught in the same manner of Goldin-Meadow et al.'s study (2009) but were not forced to use the strategy they were taught. Consequently, the participants in the current study did not actually use the strategy themselves.

Another difference from Goldin-Meadow et al.'s (2009) study was the use of verbal direction. During her study the experimenter only used the words "I want to make one side equal to the other side" (Goldin-Meadow, et al., 2009). In the present study these words were used in addition to the verbal direction of what numbers needed to be added or multiplied.

These subtle differences could account for the different findings from Goldin-Meadow et al.'s (2009) study. In Goldin-Meadow et al.'s (2009) study, only gesture was used to explain the methodology of grouping. However in the present study that same methodology was also presented verbally. This explicit verbal instruction may have explained the task excluding the need for the gesturing. This verbal instruction which was given to all conditions of gesture may have compensated for the lack of gesture in the no-gesture and partial gesture condition allowing them to achieve the same increase in performance as the gesture condition. Therefore all conditions and stages of development were able to achieve an improvement in performance where only the gesture condition was able to make improvements in Goldin-Meadow et al.'s (2009) study. This suggests that while gesture may have the ability teach standing alone, verbal instruction may also have the ability to teach while standing alone, creating no effect of gesture on verbal instruction.

Many research studies have shown a strong connection between embodiment through the use of gesture and math learning; however this connection was not seen in the present study. It is important to understand that the use of gesture is simply an additional pathway to conceptualizing mathematics. Butterworth (1999) showed multiple pathways to computing math problems in his model. While cultures such as the Yupno culture (Ward, 2006) used the body as a manipulative for symbolizing numbers, it is not the only manipulative that connects the physical and mental world. In the present study the oral language processes appear to be the dominant pathway to conceptualizing math, resulting in equivalent performance in the gesture and no-gesture condition.

In the present study, all age groups improved regardless of the use of gesture, i.e., every stage of development had a significant improvement from pre- to post-test. This did not support to hypothesis that gesture would enhance learning math. Those in the concrete stage of development learned more when considering effect size and gain scores. Future studies should look at why this occurred.

While it was found that all children learn from verbal instruction regardless of gesture, the present study was not without fault. Since there was not a condition where no practice time was given, practice effects may occur. The participants could in fact have been learning simply because they were given time to practice the types of math problems. Future studies should include a condition where no practice time is given. There was a lack of power for the amount of conditions, age groups, and developmental stages within the study. My research assistants and I will continue to run more participants over the summer. A preliminary reanalysis of the current data, by age group (ages 4-6, ages 7-8, ages 9-10, etc.) showed significant interactions of pre-post accuracy by gesture. The cell size for these groups was too small to report this as significant. However, future studies should look at age groups instead of developmental stages. Future studies should also look at the developmental stage differences for not the verbal and the gesture instruction together but at each separately in order to examine the effects of gesture on stage development without verbal instruction.

In conclusion, in this study all children learned mathematical concepts regardless of the ability level of the child, difficulty level of the math, stage of development of the learner, or condition of gesture teachings or verbal teachings. In order for Americans to bridge the gap found in mathematical abilities from their foreign counterparts, teachers need to consider using multiple methods to explain mathematical concepts. Every child can learn, based on information from other studies, it seems that multiple methods of teaching should be tested to find the best fit for the child which will in turn increase math performance for all children.

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DANIELLE J. WILSON

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EDUCATION

Plum Senior High School **2006**
High School Diploma
Penn State Erie, The Behrend College **Expected May 2010**
B.A. in Psychology, minor Civic and Community Engagement

EMPLOYMENT

Penn State Behrend, Undergraduate Research Assistant **2007-Present**
Coordinated participant scheduling and assisted in running participants in several studies (including ERPs), entering and analyzing data, and presenting results at undergraduate and professional conferences.

Achievement Center, Summer Treatment Program Counselor **Summer 2009**
Camp counselor for an ADHD summer treatment program which was run by Dr. Pelham from University of Buffalo.

Penn State Behrend, Student Psychology Lab Coordinator **2009-Present**
Schedule, train and organize Psychology lab attendants, experimenters, Psychology 100 students and independent study students. This position required one-on-one work with the Faculty Coordinator as well as group and one-on-one work with all psychology students

HONORS AND AWARDS

Runner-Up Award, Sigma Xi Undergraduate Research Conference **2008**
Schreyer Honor Scholar; Thesis project: Developmental Differences in Mathematical Learning Aided by Embodiment through Gesture **2008-2010**
Sportsmanship Leadership Award, Penn State Erie, The Behrend College Athletics **2008**
Dean's List **2007-2010**
Eclipse Leadership Award **2009**
First Place Award, Sigma Xi Research and Creative Accomplishments Conference **2009**

GRANTS

Penn State Behrend Undergraduate Research Grant, "*Spatial Visualization Research and Assessment Project: Outreach and Training"* **2008**
Penn State Behrend Undergraduate Research Grant, *"Spatial Visualization Research and Assessment Project"* **2007**
Penn State Behrend Undergraduate Research Grant, *" School Features and their Influence on Learning: Taking a Look at Green Kids"* **2009**
Penn State Behrend Undergraduate Research Grant, *" Mind and body: Embodied Cognition and its Effects on performance"* **2009**

TEACHING EXPERIENCE

Undergraduate Teaching Assistant: Cross Cultural Psychology **2008**
Penn State Erie, The Behrend College
Assisted instructor in administering lessons and quizzes. Aided students in developing individual service projects.

Teacher: House of Healing **2008**
Erie, Pennsylvania
Cared for children of previously incarcerated women while they were attending their house meetings.

Daycare Teacher: Franck's Daycare **2007**
Penn Hills, Pennsylvania
Cared for children 2-6 yr. in age. Their daily needs included feeding, bathing, and planned activity. The activities were created for them in preparation for kindergarten.

Tutor: International Institute **2006-2008**
Erie, Pennsylvania
Worked with young adults in their immigration process to the United States. Work on speaking and writing skills with the students. Supervised of after school school-age children as well.

Tutor: Penn State Behrend **2007-2008**
Erie, Pennsylvania
Worked with freshmen Chemistry students in improving their performance on Chemistry exams and homework.

STUDENT ORGANIZATIONS

Psi Chi Chapter, President **2008-2009**
Penn State Behrend Swim and Dive Team, Captain **2006-2010**
Penn State Behrend Water Polo Team **2007-2010**
Student Athletic Advisory Committee, Vice President **2006-2010**

RESEARCH NOT PRESENTED AT A CONFERENCE

The Influence of Anxiety on Working Memory and Schematic Reliance in Recognition Memory **2008-2009**
Aided in running participants, and analysis for this two-part honors thesis project across three semesters. Results will be presented at a national conference.

School Features and their Influence on Learning: Taking a Look at Green Kids **2008-2009**
Designed, organized, conducted, and analyzed this Advanced Research Projects study. Results was presented at two undergraduate psychology conferences in the spring of 2009.

ERP Spatial Training Study **2008-2009**
Assisted in organizing this year-long study by scheduling and running participants on ERP, and analyzing data. Results are to be presented at a national conference.

ERP Sarcasm Study **2008-2009**
Assisted in organizing this year-long study by scheduling and running participants on ERP, and analyzing data. Results are to be presented at a national conference.

Gender Differences in Spatial Skills: The Influence of Stereotype Threat **2008**
This study examined stereotype threat for a mental rotation task.
Assisted in running participants, analyzing data, and presenting results at undergraduate and professional conferences.

Our Spatial World **2008**
Assisted in organizing and running a spatial training study with high school and college minority students. Results will be presented at an undergraduate conference.

Developmental Differences in Mathematical Learning Aided by Embodiment through Gesture **2008-2010**
Designed, organized, conducted, and analyzed this Schreyer Honors Thesis Research Project. Results will be presented at two undergraduate psychology conferences, a thesis defense, and a national conference in the spring.

Youth Voice Project **2009-2010**
Aided head researcher by analyzing the online data collected, made revisions to online survey proposed to get at what student's perspectives are on bullying.

CONFERENCE PRESENTATIONS

Penn State Behrend Sigma Xi Research and Creative Accomplishments Conference, Erie, PA **2008**
Reducing Gender Differences in Spatial Skills: The Influence of Stereotype Threat.
James Hodge, Jessica Schubert, Kaylee Curilla, Jessica Scubert, and Janice
(with K. Holliday-Darr, J. Trich Kremer).

Western PA Undergraduate Psychology Conference, Erie, PA **2008**
Service Learning and Public Scholarship: Becoming a Real World Problem Solver
(with D. G. Blasko).

Association for Psychological Science Annual Convention, Chicago, IL **2008**
Integrating Service Learning and Public Scholarship in an Interdisciplinary Minor
(with Blasko, D.G., Trich Kremer, J.)

Penn State Behrend Sigma Xi Research and Creative Accomplishments Conference, **Erie, PA** **2009**
Individual Differences in Relational Aggression and Working Memory Capacity on Sensitivity to Sarcastic Prosody
(with L. Barnes, P. Norwood, J. Eisert, V. Kazmerski and D. Blasko)

School Features and their Influence on Learning: Taking a Look at Green Kids
(with J. Jerome and V. Kazmerski)

Western PA Undergraduate Psychology Conference, Erie, PA **2009**
Individual Differences in Relational Aggression and Working Memory Capacity on Sensitivity to Sarcastic Prosody
(with L. Barnes, P. Norwood, J. Eisert, V. Kazmerski and D. Blasko)

School Features and their Influence on Learning: Taking a Look at Green Kids
(with J. Jerome and V. Kazmerski)

Association for Psychological Science Annual Convention, San Francisco, CA **2009**
Title Effects of Anxiety and Working Memory on Schema-Based Object Recognition
(with J. Schubert, J. Jerome, and D. Blasko)

National Science Teachers Association Convention, Philadelphia, PA **2010**
Green Schools as Tools for Improving Learning
(with J. Jerome, G. McKnight and V. Kazmerski)

MEMBERSHIPS

Association for Psychological Science (student member) **2008**
Penn State University Schreyer Honors Program **2008-Present**
Psi Chi National Honor Society in Psychology **2008-Present**
Penn State Behrend Psychology Club **2007-Present**

SERVICE AND OUTREACH

Bowl-A-Thon Leader, Erie, PA **2009**
Organized and planned a bowl-a-thon to benefit a water polo athlete battling cancer.

Math Options Summer Camp, Erie, PA **2008**
Mentored young girls in a camp promoting women in math and science fields. Presented informational sessions and demonstrations in psychology, such as demonstrating ERP and eyewitness testimony. Also assisted with chemistry and engineering workshops.

MCEWISE, Erie, PA **2008**
Organized and presented a series of hands-on workshops for a psychology showcase for women and minority students.

Math Options, Erie, PA **2008**
Organized and presented information and demonstrations dealing with how math is used in psychology for a group of middle school girls interested in math and science.

21st Century Girls, Corry, PA **2008**
Presented "Psychology as a Science" to a group of middle school girls interested in Math and science. Demonstrated spatial skills and perception using games and activities.

Voices Program, Erie, PA
Organized and presented an informational session and activity dealing with cognitive psychology and spatial skills for a group of middle school at-risk youth. **2007 and 2008**

Special Olympics Volunteer, Erie, PA **2007-2010**
Aided participants in the Special Olympics to their events and helped them complete the event once they began.

TOPS Soccer Volunteer, Erie, PA **2007-2010**
Gave swim lessons and played with the siblings of the children participating in TOPS Soccer, which is a program teaching mentally handicapped children to play soccer.

International Institute Book Drive Leader, Erie, PA **2006**
Organized a campus wide book and school supplies drive for the English as a Second Language students at the International Institute of Erie.

Alternative Spring Break Volunteer, Gulfport, Mississippi **2008**
Aided Katrina victims in rebuilding their homes. School funded trip was a week long mission trip.

COMPUTER EXPERTISE

Efficient in Microsoft Word, Powerpoint, Excel, and Access
Efficient in SPSS 17.0

REFERENCES

Dr. Victoria Kazmerski, vak1@psu.edu, 814-898-6246
Jennifer Trich Kremer, jdt107@psu.edu, 814-898-6036
Jennifer Wallace, jns11@psu.edu, 814-898-7147