CHILDREN’S INFORMATION SHARING FROM

ACCURATE AND INACCURATE

SOURCES

by

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A THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Science
in the Department of Human Development and Family Studies
in the Graduate School of
The University of Alabama

TUSCALOOSA, ALABAMA

2020

ABSTRACT

Children are constantly learning new information from sources that are often, but not always, accurate. Sometimes children may find themselves with an opportunity to share the information they have learned with others. An open question is whether children share this information selectively and, if so, whether their selectivity is related to the accuracy of the original source. In the present study, 4- and 5-year-olds received contradictory information from two sources, one who was accurate and one who was inaccurate. The information came from a variety of domains including math, science, and language. Children were then invited to share the information with a naïve other (an alien named "Zorg"). The results showed that children were selective about what they shared, preferring to share information from the accurate over the inaccurate source. Further results showed that sharing was mostly similar across age and domain.

DEDICATION

This thesis is dedicated to everyone who helped me navigate graduate school through moving somewhere I had never been before, getting engaged and planning a wedding, moving again, and enduring a pandemic; especially my incredible and supportive husband who never stopped encouraging me forward, loving me endlessly, and bringing me tea when my focus was dwindling. I couldn’t have done this without you.

LIST OF ABBREVIATIONS AND SYMBOLS

f	F Statistic: shows if the means between two population are statistically different
t	Computed value of t-test
M	Mean: the sum of a set of measurements divided by the number of measurements in the set
N	Total number of individuals in a set or population
p	Probability associated with the occurrence under the null hypothesis of a value as extreme or more extreme than the observed value
η^2	Eta squared: proportion of variance associated with one or more main effects
=	Equal
$<$	Less than

ACKNOWLEDGEMENTS

I am delighted to have this opportunity to thank all of those who helped me with the completion of this thesis. I am especially thankful for the chairman of this thesis and my advisor, Dr. Jason Scofield, for his endless patience and boundless knowledge of all things related to children's learning. I want to thank my committee members, Dr. Holland Banse, Dr. Ansley Tullos Gilpin, and Dr. Sherwood Burns-Nader, who were incredibly gracious and understanding throughout not only the process of completing the project, but in my overall academic career at The University of Alabama. Once the pandemic hit and my plans for this thesis were inevitably changed, the entire committee was so considerate of the changes we needed to make, though it was relatively last minute. Elizabeth Deatkine is also deserving of so much thanks for aiding in the collection of data and her commitment to our research. I also want to thank Kaitlyn May for being a true friend and peer throughout my time in Alabama. I couldn't have completed this without your support! I finally would like to thank the parents and children that faithfully participated in this study.

None of this would have been possible without the love and encouragement of my friends, family, and fellow graduate students. I am indebted to you all.

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1. INTRODUCTION

Children are selective in their learning

Humans inherently rely on other humans to learn about the world around them. This dependence begins in infancy, as babies look to their parents to see how to react to new situations and watch their mouths to learn language (Koenig & Sabbagh, 2013; Harris, Pasquini, Duke, Asscher, & Pons, 2006), and continue throughout the lifespan. However, early in childhood we learn that not every person with whom we communicate is telling us something true or valuable (Bergstra, De Mulder, & Coopmans, 2018; Butler, Schmidt, Tavassolie, & Gibbs, 2018). Even parents have been shown to use incorrect labels for objects they don't know about (Sabbagh & Baldwin, 2001), adding doubt to their ability to be a trusted source. Trusted and trustworthy sources are generally those who have proven themselves to be reliable in the past and, therefore, those we'd prefer to learn from (Koenig & Harris, 2005a; Koenig & Harris, 2005b). The idea that we will not learn from just any person, indiscriminately, is here referred to as selective learning. It is based, in part, on the idea that we have a "sensitivity to problematic speakers" (Stephens & Koenig, 2015, p. 182). By the preschool age, children are able to hear from multiple sources and decide which is more or less reliable (Corriveau, Ronfard, & Cui, 2018; Ronfard & Corriveau, 2016; Koenig, Clement, & Harris, 2004; Lutz & Keil, 2002).

Seminal work on selective learning with preschoolers was conducted by Koenig, Clement, and Harris (2004). In their study, participants between the ages of 3 and 4 were tasked with watching video clips of two female actors who presented familiar and novel objects. Within the familiarity trials, the actors used different words to label the same familiar object. For instance, the two actors might label a ball. One actor (the accurate actor) would say "That is a ball," while the second (inaccurate actor) would instead mislabel the ball, saying it is a "That is a shoe." There would be three of these trials and the children would subsequently be asked which of the actors said things that were right and which said things that were wrong. The same actors would then use different words to label the same novel object. For instance, the children would be shown an item they had never seen before, and the first actor would say "That is a toma," while the second would say "That is a mido." The children would then be asked to tell what the object was called. The researchers found that both age groups performed at above-chance levels on siding with the name given by the accurate source, with four-year-olds performing slightly better than the three-year-olds. This suggests that children are more prone to learn novel lexical information from a source who has previously shown themselves to be accurate.

The idea that children prefer to learn from an accurate or reliable source is also suggested in the findings from Sabbagh and Baldwin (2001). In this study, the researchers did two studies to see if children considered a speaker's self-professed knowledge state when that speaker was teaching the child new words. Study 1 examined how 3- and 4-year-olds learned a new word in reference to a toy in one of two conditions. In the speaker-knowledgeable condition, the speaker said they knew exactly which toy out of the 3 presented was the blicket or the dawnoo (two novel and unfamiliar words). In the speaker-ignorant condition, the speaker said they were not sure which toy was the blicket or dawnoo but just made a guess. Children were then asked to point out which toy was the blicket or dawnoo. The results showed that children in the speaker-knowledgeable condition displayed better word learning than their peers in the speaker-ignorant condition. Study 2 utilized 3- and 4-year-olds in a similar method but this time the speaker was always ignorant about labelling a toy with the novel word. However, this experiment also had two conditions. In the first, the speaker said his friend made the toy and called one the modi or toma but he wasn't sure which, expressing ignorance of the label. In the second condition, the speaker said he had made the toy and wasn't sure which to call a modi or toma, expressing that he had yet to decide what to call it until the experiment. In this, the older children seemed to show better word learning from the speaker who made the toy while younger children showed poor word learning in both conditions.

These studies provide evidence that children learn better from speakers who are more knowledgeable and reliable when in conditions in which they are aware that one speaker knows more or is more competent than the other. Furthermore, children take in information from a given speaker and decide what to accept and what to reject (Butler et al., 2018). These studies also show that the research on selective learning in domains outside of word learning is limited. While the body of knowledge on word learning is vast, children will generally encounter many more subjects to learn in the real world. This includes subjects such as math and science. The next section will discuss how children make the differentiation between sources on their own.

Children selectively trust

It is possible that, after learning from family members and teachers in school, children could assume that any adult is a trustworthy source (Harris, 2012). However, studies have shown that by age three children are more discerning in their selections of teachers and assessing the knowledge of others (Sabbagh & Baldwin, 2001; Clement, Koenig, and Harris, 2004; Stephens & Koenig, 2015; Lutz & Keil, 2002; Aguiar, Stoess, & Taylor, 2012; Jaswal & Neely, 2006). This could be an understanding that the speaker is making an honest mistake, lying, joking, or not making it obvious that their testimony is either factual or fictional (Bergstra et al., 2018; Butler et al., 2018; Birch et al., 2008). Therefore, children can decide if a source is reliable or unreliable and yet not totally trust in a known reliable source (Li & Yow, 2018; Clement et al., 2004).

This is exemplified in Clement, Koenig, and Harris' (2004) study on the ontogenesis of trust. The authors tested 3-, 4-, and 5- year old participants to see if the children would display what they referred to as "gullible" trust (trusting a known reliable informant over even oneself) or "skeptical" trust (trusting what they had seen themselves over the informant's description). In their study of gullible and skeptical trust, the authors had experimenters sit at a table across from the participants with two puppets - a frog and a mouse. They explained to the children that the puppets were both very nice but one answered questions with the right answer and the other answered questions with "strange" answers. For instance the experimenter would start by putting a banana on the table in front of the child. In the condition where the mouse was acting as the reliable informant, the mouse puppet would label the banana correctly (e.g. "That is a banana!") and the unreliable frog would give the strange answer (e.g. "That is an orange!"). This was done with three objects. The authors then used pom poms and a box in their "prediction task" to ask children to predict what color pompom each of the puppets would guess was in the box, after showing that pom pom to the children. They performed several iterations of these tasks to test how children trusted both the puppet informants and their own observations. The authors found that most of the older children were able to distinguish clearly between the reliable and unreliable puppets. Furthermore, the older children would more often (64.3%) rely on their own observations than would agree with the reliable puppet (14.3%), while some (21.4%) suggested a different answer than what the puppets gave or what even they themselves had experienced. When justifying their answers, the group of children who prioritized their own observations referred back to having seen the pompom themselves, showing marginal signs of gullible trust in the reliable informant. This effect was less significant in the younger children.

In summation, children can differentiate between reliable and unreliable sources without explicitly being asked to make that choice. More than that, they rely on their own observations more often than those of even a generally reliable source or one with a reputation for being knowledgeable.

Children share information – children as teachers

In early childhood, children are not only excited to learn about someone else's beliefs, knowledge, or experience, but can be just as excited to share their own belief, knowledge and experience with others, understanding that not everyone knows exactly what they know (Miller, 2000; Rhodes, Bonawitz, Shafto, Chen, & Caglar, 2015; Davis-Unger & Carlson, 2008; Gweon, Shafto, & Schulz, 2018). However, children may not openly share just any information that they have learned (Ronfard, Was, & Harris, 2016; Baer & Friedman, 2018). While selective learning is well studied, selective teaching – an activity that is purposefully designed to bring another's knowledge into agreement with one's own (Davis-Unger & Carlson, 2008) - has a much smaller body of research (Kim, Paulus, Sodian, Itakura, Ueno, Senju, and Proust, 2018).

One of the first examples of examining children as teachers was done by Pratt, Scribner, and Cole (1977). The first of the two studies they used involved first and third grade students and separated them in half by speakers and listeners. The speakers were taken to a room by the researchers and taught a game using mostly gestures and some talking. While the speakers were learning to play the game they were told they would subsequently teach the game to a child who was a listener and didn't know anything about the game. The speakers then tried to teach their listener partner how to play. Within this study design was four conditions: (1) both children could see the game board, (2) only the speaker could see the game board, (3) only the listener could see the game board, and (4) neither of the children could see the game board. The researchers coded for the amount of information given by the speaker, the explicitness of that information, the sequence of the information given, and the expression in the explanation. Using these methods, researchers found that children shared more information when the listener could not see the game equipment, and older children shared more information more often. Furthermore, these and the other findings within this study suggested that the speaker adapted their information to the listener. The second study implemented examined preschool children between the ages of 4 and 6 years with the same procedures as study one except the low screen (which restricted view of the game equipment but not partners' view of each other) was present in every condition. Results showed that 62% of speakers provided at least one descriptive statement about the game equipment when the equipment was not provided to the listener. These young children showed low explicitness in their explanations, with the researchers going on to note that speakers would share less information if they believed the listener already knew the some of that information. (Pratt et al, 1977).

A more recent example of research on children as teachers comes from a study done with Japanese and German children (Kim et al., 2018). Participants were 4- and 6-year old Japanese children and 4- and 6-year old German children living in their respective countries. In order to study both selective learning and selective teaching, the researchers had the children watch videos in which puppets either knew or did not know the contents of a box. There were two conditions: the learning condition (children did not see the box contents) and the teaching condition (children were able to see the contents of the box). After watching the puppets either look in the box or not, children were either asked to choose one puppet to inform about the contents of the box (teaching condition) or asked about the contents of the box (learning condition). Across the results, 6-year old children out performed their 4-year-old peers in both learning and teaching conditions. However, there was a cultural difference in the results. Japanese children were more adept at selectively teaching a more ignorant other while German children did better to learn from the knowledgeable speaker.

These studies overall suggest that children are willing and ready to teach others new information, and generally prefer to teach accurate information. That is, when they can't gather information from first-hand experiences, children are able to monitor reliability of informants and subsequently teach information which they believe to be accurate. Importantly though, teaching is just one example of information sharing children. That is, children may feel the urge to share information for which there is no learning expectation.

Integrating STEM domains

While the results of the previous studies outlined are valuable and provide the basis of much of the framework of the present study, they are primarily centered around word learning. It is imperative to children's learning that they are able to select and reject what information to take in (Butler et al., 2018), especially in a modern world inundated with information of various reliability so freely available. Because so many previous studies focus on word learning, there is still room for research on how children selectively learn, trust, and potentially share information from other domains. This is particularly true for STEM (science, technology, engineering, and math) domains; studies have shown that knowledge of STEM in early childhood is widely perceived as having educational and economic value, as well as the potential to pave the way for future success (Wan, Jiang, & Zhan, 2020). Academic achievements within the field of STEM can also contribute to careers of high esteem and increased innovation (Stoeger, Hopp, &

Ziegler, 2017). Despite the push for integrating STEM and the perceived benefits of integrating STEM into early childhood, not all children have easy access to STEM knowledge and may have limited experience with STEM fields prior to formal school.

One study that was able to examine children and science learning was that by Harris and colleagues (2006) in which the researchers studied how children believed in and endorsed the existence of entities they could not see or experience for themselves but had been given testimony about. Some of the entities included in the study were scientific, like germs and oxygen. The overall results suggest that children favor accurate testimony when it comes to science at rates that are similar to their rate of favoring accurate lexical information.

Because we know STEM to be of increasing importance in educational settings, and the fact that there is little work already done to examine how children selectively learn and share STEM information, the present study looked to take previously established methodology and adjust it to allow researchers to integrate math and science. Understanding the ways in which children evaluate and share STEM information can provide insight into how to utilize children's sharing propensities to support STEM learning. It also can encourage children to have more meaningful conversations about science and math with adults and peers.

In summation, we know young children have the ability to selectively teach and learn, new information selectively. We also know that a majority of work done on this topic focuses on word learning. In reference to the present study, children were asked to learn from a variety of sources who showed themselves to be either reliable or unreliable and then were invited to share the information they learned. This study differed from previous studies and sought to add to the overall body of research as it looked at selective sharing over selective teaching; that is, children shared information without consideration of whether the recipient of information had learned or fully understood what was being shared. Furthermore, this study looked beyond lexical stimuli to examine learning and sharing in other domains too, such as math and science.

The Present Study

Evidence has shown that children learn selectively – they do not take in just any information as truth and they can differentiate between a reliable and an unreliable source. However, previous studies end there without asking children to then share that information. The present study had three history trials to help children determine reliability before going into the test trials. There were two informants saying conflicting bits of information (e.g., "This floats in water" versus "This sinks in water). This allowed the researchers to seek to understand how children share information which they did not learn from personal experience but instead heard from sources that had shown themselves to be either reliable or unreliable.

There is a relatively small body of research on how children teach others, and even less on how they share information – the difference herein being that, for sharing, children are not checking for understanding and making sure the listener retains the information. The present study asked children to share information with a more ignorant other – and that other listened to the child before then leaving without a word, letting the child complete their next task.

Selective learning and teaching are important to any person who works to ensure children's learning is at its highest potential. Understanding how children learn, from whom they learn, and what they prefer to learn could dictate the best possible teaching methods and strategies. Yet, most of the research about children's selective learning and sharing revolves around word learning. The present study used trials of word learning but also included trials within STEM domains (math, life science, and physical science) as guided by state standards for kindergarten-level education in the state of Alabama as well as national standards for the United

States. This was done so that the information being tested has real-world application as it relates directly to what children are learning in school. Then, the researchers may contribute to answering the question: when children learn across domains within the classroom, how might they take in and share out some of the information learned?

2. METHOD

Participants

The participants were 41 4-year-olds (N=23, *M*=55 months) and 5-year-olds (N=18, *M*=65 months) from the area around the university as well as from a childcare center in Texas. There were 20 boys and 21 girls. Of the 41 participants, 33 were white, 4 were Asian, 3 were black, and 1 was Hispanic. Participants were recruited with parental consent and participant assent from childcare centers. Previous studies on this topic typically recruit participants within a similar age range. Although SES data was not collected, the participants were recruited from an area with a typically middle to middle-upper SES. One participant chose not to answer the explicit judgment task questions, however his responses were included in the data set; his non-responses were coded as incorrect, making the end results a more conservative representation of overall scores. The researchers examined data with and without this participant's data and found that the overall pattern of results were the same.

Design

This study used a 2 by 4 design with 2 representing the two age groups (4- and 5-years-old) as the between subjects variable and 4 representing the four domains (math, words, life science, and physical science) as the within subjects variable. The examined outcomes were identifying accurate information, the information that children shared (from the accurate or inaccurate informant), age differences, sharing across domains, and the explicit judgment task. This task asked children to decide between informants who were accurate or inaccurate. The study used a forced-choice design so that children were given two choices for explicit judgment (accurate or inaccurate informant) as well as two choices per slide of each test trial (accurate informant's information or inaccurate informant's information).

Materials

The materials used for this study included a laptop which held 24 slideshows created by the researchers showing 48 video clips (2 per slide) that showed two of 8 different informants (female volunteers from the university in all different colored t-shirts), 18 images of novel or familiar objects, with two videos and one object per slide (see Figures 1 and 2). Each slideshow had 48 slides, which included title slides, test/history trial slides, and slides used to assess the children's explicit judgment. There were 2 trials (history and test trials with 3 slides each) per domain within the four domains of math, words, life science, and physical science. Science and math facts used to create these trials were chosen from both state (Alabama) and national science standards for pre-k and kindergarten level knowledge bases. Along with the laptop was a ZOOM H4nSP Handy Recorder that allowed experimenters to record audio to later code children's responses. There was also an alien puppet which was soft fabric and about 20 inches long that was able to be sat upright. This alien was called "Zorg" for the sake of the experiment and Zorg's pronouns were changed to be gender matched to each participant. When Zorg was not out for the children to share information, the puppet was placed inside a cardboard spaceship which had a painted front that made it look like a spaceship (a large blue dome on a striped colorful base) and was connected to a box that Zorg could fit in without the children seeing. The researchers also had data sheets and a writing utensil to make notes of children's responses. These sheets also had a script that allowed the researcher to tell the participant more about the study as well as information on Zorg.

Procedure

Before the children arrived into a quiet, familiar space within their center that was away from their classroom, researchers set up the space so that there were two chairs facing a table. The table had a laptop ready with the presentation trials for the children to view. There was also be a cardboard spaceship containing an alien puppet, as well as an audio recorder so that the researcher could later code responses. Children would be seated so that they were between the researcher and Zorg, making the researcher reach past the participant to bring Zorg from the spaceship. The laptop was set out in front of both the child and the researcher, and to the side of the spaceship. The recorder was closest to the child, near the laptop.

Consented children were then brought in and the researcher set the recorder to start. First, children were read the assent script and invited to participate in the study. Once granted assent, the researcher would conduct a brief, getting-to-know you warm-up period before children were introduced to "Zorg", the alien puppet who resides in the spaceship. Zorg's pronouns were gender-matched to the participant. During the introduction, Zorg was described as an alien coming from a planet very far away from Earth who didn't know anything about our planet. Furthermore, children were told that Zorg doesn't talk but just listens and couldn't hear anything while in the spaceship. Zorg was then returned to the spaceship.

Following the warm-up period and Zorg's introduction, children began the experimental session. In total, the children completed eight trials within the four domains of math, life science, physical science, and words. The domains each had a history trial (with familiar objects) and a test trial (with unfamiliar objects). In each trial there were three slides that had a picture of an object and two video clips. One video clip showed an accurate informant and one showed an inaccurate informant. Every informant was a female volunteer who wore a different colored tshirt. In the history trials, children were shown familiar objects and the informants gave conflicting testimony about the object shown (See Table 2). For instance, in the words domain, the slide had a picture of a ball and one informant would say "This is called a ball" while the other informant said "This is called a book." After each informant spoke, the researcher would repeat what she said. Then, the researcher asked the child which answer was correct (e.g. "Is that called a ball, or a book?) After the history trials within the domain, children were shown a slide that just had pictures of each of the informants from that trial and asked, "You heard two people say things. One said things that were mostly right and one said things that were mostly wrong. Which one said things that were mostly right/wrong?" in what was known as the explicit judgment task. They were asked to identify the "right" informant half the time and "wrong" the other half. This also served to show the researcher which informant the child was identifying as more accurate. Then the children moved into the test trials within that same domain. In the test trials, children were shown unfamiliar objects and the same informants gave conflicting testimony about that object (See Table 3). For instance, in the life science domain, the slide would have a picture of an unfamiliar animal and one informant would say "This lives in trees," while the other said "This lives on the ground." Again, the researchers would repeat what the informants said for the child. After the slide with the informants' testimony, researchers flipped to a slide that only showed a picture of the object. The researcher then told the child that this object was one that the alien puppet Zog was interested in learning about, and they would now bring Zorg out so that the child could tell Zorg about that object. Once Zorg was brought from the spaceship, children were asked to choose to tell Zorg information about the object using the testimony given by the informants. Using the example of the animal in the life science domain, researchers would say to the child: "Tell Zorg about this thing. Does it live in trees or does it live on the ground?" Children were encouraged to give their answer to Zorg and not to the researcher – and due to the positioning of the researcher in comparison to Zorg, children would have to look away from the researcher and towards the puppet to give their responses. Once the information was relayed to Zorg, the researcher would say that Zorg was going back to the spaceship and wouldn't be able to hear anything from in there. Then the researcher would move on to the next domain.

Domains were counterbalanced so that each child viewed them in different orders. The informants were also shown on different sides of the slide in order to counterbalance that aspect of the presentation trials. Furthermore, half of the total amount of presentation trials (24 were created and used at least once each) had one set of the novel information given by the accurate informant (e.g. "This thing has many teeth) while the other half used the conflicting testimony (e.g. "This this doesn't have any teeth") being given from the accurate informant.

3. RESULTS

In this study, children were given conflicting information and asked to share some of that information with a more ignorant other across the four domains of life science, physical science, math, and words. Through having children complete multiple presentation trials with novel and familiar information, the researchers sought to answer the following questions: 1) How do children share information with a more ignorant other when the information they have is conflicting in nature and from informants who have shown themselves to be either accurate or inaccurate?, 2) Are there differences in how information is shared across age?, and 3) How does information sharing vary across the four domains (life science, physical science, math, and words)?

The researchers scored the responses slightly differently by task. For the explicit judgment task, the researchers coded responses based on who the children identified as the accurate informant. If they identified the informant that did say accurate things (e.g. saying "Ice melts when it gets hot") as the person who said things that were mostly right, their response would be coded as "1"; likewise for choosing the inaccurate informant (e.g. "Ice melts when it gets cold") when asked to identify the person who said things that were mostly wrong. If the child chose the wrong informant, their response was coded as a "0". Similarly, in the history trials, if the child identified the accurate information on each slide, their response was coded as "1". Their response was coded as "0" for siding with the inaccurate information. Participants who chose the inaccurate informant had their responses examined to see if they would still side with that informant in the test trials. The children would then complete the explicit judgment task, where they were asked about which informant was "mostly wrong" (half of trials) or "mostly right" (half of trials). Correct responses would be coded as a "1" and incorrect responses would be coded as a "0". For the test trials, the child's response would be coded as "1" for sharing information with Zorg that came from the accurate informant and "0" for sharing information from the inaccurate informant. Therefore, the child would end with a score of 0-3 for each history trial, 0-1 for each explicit judgment task, and 0-3 for each test trial within each domain. This told the researcher how many times out of three that a child would side with the accurate informant. In total, the children received a score out of a possible total of 12 for all four domains combined in the history trials, 4 for the explicit judgment task, and 12 for the test trials.

Accurately Judging the Facts

Within each domain, children underwent three history trials. In these, children saw two informants give testimony about an object which was likely known to them (See Table 2). To see how often children were able to identify accurate information in the history trials, a one-sample t-test was performed and suggested that, across all domains, children responded with the accurate information at a rate higher than chance. That is, in this forced-choice experiment, children could choose an answer at random and would statistically guess the accurate informant's information to be true 50% of the time. In this experiment, that would have been 6 out of a total of 12 opportunities in the history trials. That one-sample t-test showed that participants favored the accurate information at above-chance rates with a mean score out of 12 of M = 11.54 (SD = 1.185), $t(40) = 29.91$, $p = .000$. This overall pattern was seen separately in both 4- and 5-year-olds. The 4-year-old participants had a mean score of M = 11.22 (SD = 1.506) out of 12, $t(22) = 16.61$, $p = .000$. The 5-year-old participants had a mean score of M = 11.94 (SD = .236) out of 12, $t(18) = 107.00$, $p = .000$.

To examine the rates at which participants identified accurate information in the history trials by domain, an average score was calculated from the 3 history trials across the four domains. Then a 2x4 mixed factorial ANOVA was performed with 2 as each age group (between subjects) and 4 as each domain (within subjects). The results showed no interaction between age and domain. The suggested overall that accuracy did vary by domain, $f(3,37) = 4.325$, $p = .006$, $\eta^2 = .102$, but not by age, $f(1,39) = 5104.91$, $p = .083$, $\eta^2 = .077$. Follow-up analysis of the domain effect indicated that the primary difference across domains was found in physical science. Out of a possible 3 (wherein the children identified accurate information three times for each domain), children chose the accurate information less often on physical science trials (M = 2.79) compared to life science (M = 2.96, p = .024), math (M = 2.93, p = .072), and words (M = 2.98, p = .013). These means of life science, math, and words did not differ from each other.

Explicit Judgments of Informant Accuracy

At the end of the history trials, children were asked to identify either the accurate or inaccurate informant in the "Explicit judgment" task. Results suggested that children across age groups were able to complete this task at above chance rates. A one-sample t-test showed $t(40)$ = 14.30, p = .000. In looking at the average amount of times in all domains that children correctly identified accuracy to an informant, statistical analyses showed M = 3.73 (SD = .775) out of a total of four times. This overall pattern was also seen between age groups. The 4-year-old group showed a mean score of M = 3.57 (SD = .992) out of a possible 4, and t-test results of $t(22)$ = 7.57, p = .000. 5-year-old participants also showed a mean score of M = 3.94 (SD = .236) out of a possible 4 and t-test results of $t(17)$ = 35.00, p = .000.

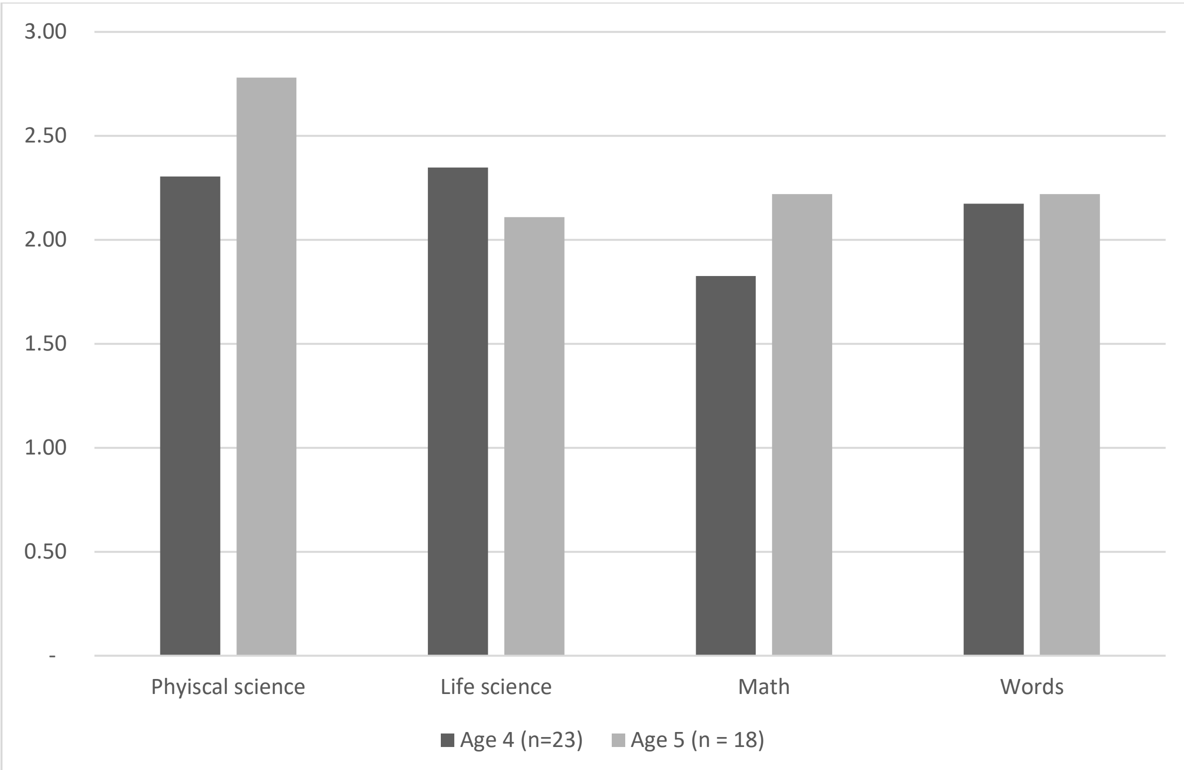
Across domains there was very little difference in the rates at which children successfully completed the explicit judgment tasks. Out of a possible score of 1 (as children were asked one time per domain), participants showed average means of *M* = .95 (*SD* = .22) physical science, *M* = .95 (*SD* = .22) for life science, *M* = .93 (*SD* = .26) for words, and *M* = .90 (*SD* = .30) for math. A 2x4 mixed factorial ANOVA showed no significant effect for domain with $f(3,37) = .626$, $p = .600$. There was also no significant effect for age with $f(1,39) = 2.51$, $p = .121$, and $\eta^2 = .06$.

Sharing Novel Information with a Naïve Listener

To see the rates at which children shared novel information with a more naïve listener, the participants completed 3 test trials for each domain (see Table 3). The data from test trials (see Table 1) were examined much like the history trials – children were asked to share information a total of 12 times. The average score of which children across age groups shared information from the accurate informant was *M* = 8.95 (*SD* = 2.190) out of 12. A one-sample t-test suggested children across age groups shared the accurate informant's information at above chance rates, $t(40) = 8.627$, $p = .000$. Both age groups showed this same pattern when examined separately. The 4-year-old participants shared information from the accurate informant an average of *M* = 8.65 (*SD* = 2.058) out of 12 times. 5-year old children shared the accurate informant's information an average of *M* = 9.33 (*SD* = 2.351) out of 12 times. In a one-sample t-test, 4-year-old results showed $t(22) = 6.18$, $p = .000$ while 5-year-old participants' results showed $t(17) = 6.01$, $p = .000$.

Table 1

Sharing Information across Domains



To help answer how children share information with a more ignorant other when they receive conflicting testimony from two informants, a 2x4 mixed factorial ANOVA was conducted with age (4- and 5-years) as the between subjects factors and domain (math, words, physical science, and life science) as the within subjects factors. The analysis revealed no domain by age interaction, but did show a significant main effect of domain $f(3, 37) = 3.471$, $p = .018$, $\eta^2 = .082$, but no main effect of age $f(1, 39) = .98$, $p = .329$, $\eta^2 = .024$. Domain was examined more closely in the data to see how children shared information with a more naïve other. As children were asked three times to share information within each domain, they could have a total score of 3 for either physical science, life science, math, or words. Descriptive statistics showed that physical science information was shared at an average of M=2.541, life science an average of M=2.229, words an average of M=2.198, and math an average of M=2.024

out of 4 times (See Table 1). Therefore, it was overall suggested that information was shared from the accurate informant a majority of the time, and at a rate higher than chance alone, across both domain and age.

4. DISCUSSION

Research on children's selective learning suggests that in early childhood, and even before entering formal schooling, children differentiate accurate from inaccurate information (Koenig et al., 2004; Butler et al., 2018; Bergstra et al., 2018; Koenig & Harris, 2005a; Koenig & Harris, 2005b). They understand that informants sometimes provide misinformation: including lies, mistakes, or jokes (Bergstra et al., 2018; Butler et al., 2018; Birch et al., 2008). Therefore, they come to know that not everything they hear is true (Sabbagh & Baldwin, 2001; Aguilar et al., 2012). In this same developmental period, children will also share information that they learn from testimony or by first-hand experience, and can decide whether or not, and how, they want to share that information (Corriveau et al., 2018; Ronfard et al., 2016; Ronfard & Harris, 2018).

The current study aimed to explore children's information sharing more broadly, especially in response to receiving conflicting testimony. Here children share newly learned STEM information with a naive other, one who did not know any better as to the accuracy of that information. Along the way, the researchers checked to ensure children heard information correctly and could judge which informant was accurate or inaccurate. This study also expanded on the current knowledge base within the field by testing participants in three novel domains: life science, physical science, and math.

To begin each domain within the overall test, children were asked about information they would very likely already know in the History Trials. Commonly known opposites were used (e.g. wet and dry, water and air, less and more) so children could be highly aware that the information they were hearing was conflicting in nature. Here, data showed the participants across age groups identifying accurate information at a rate that was higher than chance. That is, in the forced-choice design of this study, children could have chosen between two answers and, even if they just guessed, would select the accurate information about half the time. The information provided to them was conflicting in nature and by two informants. Prior research has shown that children within the age range tested are aware that sometimes the information given to them can be false; the person sharing that information can be mistaken, lying, or joking (Bergstra et al., 2018; Butler et al., 2018; Birch et al., 2008). Therefore, the history trials were not only to ensure if children could identify that an informant may be inaccurate, but also to make sure children were able to identify accurate information. It is possible that children could have sometimes misheard or misunderstood the informant. To combat this, the researchers included an image of the subject of the informants' testimony. Furthermore, the researchers in the room with the participants would always repeat what each informant said so that the children would be sure to hear more correctly. However, there was one item at which children performed at chance levels. This was within the math trials, where children were shown a picture of a cat with 3 dogs. They were told by the accurate informant, "There are more dogs than cats," while the inaccurate informant said "There are more cats than dogs" (See Table 2). Children identified the correct information 54% of the time while performing over 70% on other math items. Future studies could use a additional measures of language or counting to ensure that children have the base knowledge to correctly judge the accurate and inaccurate information.

Once children completed the history trials, researchers had them complete an explicit judgment task to see if the participants could identify accurate and inaccurate informants. We know from previous work that children within the age range studied are able to identify accurate and inaccurate informants, though usually within word learning (e.g., Koenig et al., 2004). In this study, statistical analyses suggested that children were able to do so here, regardless of age, at a rate higher than chance. While future studies could look at how children complete these tasks when allowed open-ended responses, this study used a forced-choice design, and therefore children were given two options from which to choose. As with the history trials, participants could have guessed either informant's testimony to share with a success rate of 50%. Yet, in this study, participants were able to identify the accurate or inaccurate informant 3.73 out of 4 times, or about 93.25% of the time. This indicated to researchers that the children were aware that one of the informants they saw was more right than the other. This was also important for the study so that, in the succeeding test trials, children had in their minds that one informant was usually accurate and the other inaccurate. Studies have shown that children can anticipate that informants who were historically right or wrong would continue to keep that same reliability in the future (Clement et al., 2004). Therefore, these practices increased the chances that the participants would enter the test trials with the knowledge that one informant was more likely to be right or wrong. One more interesting finding from the explicit judgment tasks is that the overall result patterns remained the same when researchers examined the differences in the data set when analyzing only those who passed the explicit judgment task on 75% or more trials (i.e., both 3 out of 4 times as well as those who passed 4 out of 4 times). This further points to children's preference to accurate speakers overall, even when explicitly judging one informant incorrectly.

When examining how children shared information across domains and how they judged accurate and inaccurate informants, children across age groups showed a strong preference to sharing information with a naïve listener that they heard from an informant that they judged to be generally accurate in their testimony. This is in agreement with previous work on children's selective learning. The children in this study shared information from the accurate informant most often in the domain of physical science. This is especially interesting seeing as the lowest rates at which children agreed with accurate information in the history trials was also in the physical science domain. That is, participants chose the inaccurate informant in physical science history trials more often than any other domain while sharing the accurate informant's information in the test trials. The reason for this phenomenon is not clear, nor can reliably be guessed upon. It is possible that there was some confusion in the history trials. That is, the physical science trials asked children if ice melted when it got hot or when it got cold. It is also possible that children had the least knowledge about physical science in the history trials and therefore chose to rely on an informant more heavily in the test trials. This would make sense as we know that children must rely on the testimony of others when they don't have first-hand knowledge of their own (Harris, Pasquini, Duke, Asscher, & Pons, 2006).

It is that topic, children's selective sharing, that was one of the foremost focuses of this study. The methodology and purpose of this study deviated from previous work in that a majority of previous studies referenced look at selective teaching. While selective teaching is a type of sharing, they have different goals. The goal of teaching is to ensure that the recipient of information fully understands what is shared. Sharing information doesn't necessitate the other party learning the information, but that it is simply heard. It is well known that children often share information with others. This can be information that they've learned, what they have experienced, or things about themselves. Miller (2000) states that people share information (and seek information) because "there is some perceived difference between what the self knows and what the other knows." (p. 260) The present study emphasized that the recipient of the information shared was more ignorant than the child, however once information was shared with the alien puppet, the puppet simply went back to the spaceship without a word. Previous work suggests that children do consider the listener’s mental states when they provide them with information (Rhodes et al., 2015). This study used 4- and 5-year old participants, coinciding with age groups that previous, similar studies used. This would be considered appropriate as studies have shown that children can understand that others lack knowledge by the time they are around 3-years-old (Davis-Unger & Carlson, 2008). The data from the present study suggested that, when children share novel information with a more naïve other, and the information they have is conflicting, they prefer to share information that comes from a speaker who has shown themselves to be previously accurate in that domain.

Another primary focus of this study was to ask how children share information across age groups. The results suggested that there was very little variation across age. Both 4- and 5-year-old children preferred to selectively share information from an accurate source. It is possible that a larger sample size would yield different results by age group. In this study, all children did share similarly across all domains – including those other than the domains traditionally studied. Much of the work on this subject look to word learning to test their hypotheses (Sabbagh & Baldwin, 2001; Koenig & Harris, 2005a; Jaswal & Neely, 2006). This study looked to examine how children share information from the STEM domains. It is known that STEM knowledge has been brought to the forefront of important topics in early childhood, as more people realize the potential for future success and innovation STEM can bring success (Wan et al., 2020; Stoeger et al., 2017). Beyond looking to STEM for future economic gain, the field can be looked at as an opportunity to learn more about collaboration (Guyotte, Sochacka, Costantino, Walther, & Kellam, 2014). The other fields within academic settings can be integrated with STEM to improve and increase learning for children. The data from the results of this study suggest that children share STEM domain information from an accurate source at rates higher than chance. It should be noted, however, that this study tested participants who were primarily recruited from a lab school and a school on a scientific organization's campus. Therefore, these participants likely had more exposure to STEM than the average child might. The results here further indicated that children may be sensitive to taking in and sharing testimony about STEM domains just as they are about word learning. In a modern world where information of all kinds is readily available to children, it is important to know more about how they are selective with learning that information.

There is a plethora of work on selective learning and the ways children rely on others for testimony. This is especially true for word meanings where, as children grow up, others are the only source of information available (Koenig & Sabbagh, 2013). The present study helped to show this this may also be true for STEM domains, where a novel object is seen and the only source of information about that object is two informants who have conflicting testimony. Within science and math, the present study often gave testimony to participants about something that they could not see or experience (e.g. "This is hard/soft on the bottom" or "This has no/many sharp teeth). The data found suggested that children extend their propensity for selective learning, and sharing, into science and math domains, beyond word learning. Children prefer to learn from adults, and generally have an expectation that people older than themselves will be more "cognitively competent" (Miller, 2000) than those who are younger. This study used female college students as the informants so that children would be more comfortable learning from them than, say peers. However, this does suggest future directions with how children learn in the STEM domains from others of a similar age to themselves. This study also agreed with previous works in that they participants preferred to learn from a source who had shown themselves to be previously accurate.

Previous research has shown that children are usually able to assess the knowledge of others (Aguilar et al, 2012). Children must accept and reject information so that they can learn (Butler et al., 2018). The present study gave children conflicting information so that they could be sure someone was right and someone was wrong. Therefore, they were inherently making a choice to selectively trust one informant over another as they proceeded to share information. The data of this study suggest, through the findings of the history trials and the explicit judgment task, that the participants were able to distinguish between both accurate and inaccurate informants and information. This coincides with previous studies on children's ability to identify reliability and unreliability in the testimony of informants.

The findings of this study give way to more considerations for future studies with similar questions and variations. It would be interesting to look at the possibility of the trials presenting only one informant. That one informant could be either accurate or inaccurate. Therefore, the inaccurate informant would leave a question about how the child would share novel information that they know is likely to be wrong. This could go with another future direction, as previously mentioned, in allowing open-ended responses. Children would then have the option to qualify their responses (e.g. "I'm not sure, but maybe…"), respond with their first hand observations (e.g. "I'm not sure if it sinks or floats but it is red and round…"), say the opposite of what the informant says (e.g. "She said this has no teeth, so it must have many teeth"), or to say nothing at all.

Furthermore, there is room in the body of research for more studies looking at domains outside of word learning. While this study included STEM domains, it is one of the first of its kind to do so. The results of this study could also look different with populations who have more or less exposure to STEM. This could affect how children view STEM information. Future work could also look at how children share information from informants when given the opportunity to explore the information first-hand. For instance, if hearing from informants that dirt gets either wet or dry in the rain, children could be given some dirt and water to make their own conclusions about which informant is more right. More research could be done not only on STEM domains, but others that children will encounter in a school setting, such as social studies or art. Future work that does include word learning as a domain could include language measures to examine any potential link between language capabilities and further word learning and sharing. Another direction for future work could change the listener and informant characteristics from this study; research could examine how children share information with a listener who is more knowledgeable or just as knowledgeable as they are, or an informant who is in the same age range as them. Lastly, future work could look to further differentiate selective teaching from selective sharing. While the current study did not establish a pedagogical motivation in children and did not include a check with the naïve other to ensure understanding, there were elements of this sharing paradigm that resemble a more intentional, teaching task. This includes the focus on sharing academic-type (i.e., STEM) information with a naïve other who doesn't know anything. The limitations of this study include the limited sample size as well as the lack of diversity in the race and socioeconomic status of participants. Another limitation is the possibility that asking children to share is really amounts to asking them to verbalize what they have learned. That is, how different would children's responses be if in one case they were asked to share with a naïve other (like in this study) and in another case they were asked to tell the experimenter what they learned. A study that better differentiated a sharing outcome (where children say the information out loud) and a learning outcome (where children say the information out loud) would clarify how different the two are.

In conclusion, the children in this study preferred to selectively learn from an accurate source as well as selectively share from an accurate source. The data suggest that this selectivity in sharing was indeed based on the accuracy of the informant's past testimony. The results present interesting information about how children share testimony across word learning, math, physical science, and life science. It is clear there is room for more work in this field, especially in seeing how children selectively learn and share information from the STEM domains. The findings here detailed contribute to the field of selective sharing as they do not focus so much on selective teaching (as many previous studies have done) while expanding some existing methodologies to new domains. Knowing that children prefer to share STEM information from an accurate source more often than an inaccurate source can help to inform practice that promotes conversations about STEM and, therefore, increase children's interest in the field.

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APPENDIX

Table 2

History Trials

Domain	Image	Accurate Statement	Inaccurate Statement
Physical Science	Ice cube melting	Ice melts when it gets hot.	Ice melts when it gets cold.
	Pile of dirt	Dirt gets wet in the rain.	Dirt gets dry in the rain.
	Broken glass	Glass breaks when hit by a rock.	Glass breaks when hit by a feather.
Math	3 dogs, 1 cat	There are mores dogs than cats.	There are more cats than dogs.
	Tall girl, short boy	The girl is taller than the boy.	The boy is taller than the girl.
	Circle	Circles are round.	Triangles are round.
Life Science	Turtle	Turtles have a shell on their back.	Turtles have wings on their back.
	Bird	Birds fly in the air.	Birds fly in the water.
	Plant	Plants need water to grow.	Plants need candy to grow.
Words	Cup	This is called a cup.	This is called a shoe.
	Key	This is called a key.	This is called a spoon.
	Ball	This is called a ball.	This is called a book.

Table 3

Test Trials

Domain	Image	Accurate Statement	Inaccurate Statement
Physical Science	Red object	This floats in water.	This sinks in water.
	White object	This turns red in sunlight.	This turns blue in sunlight.
	Black object	This is soft on the bottom.	This is hard on the bottom.
Math	Brown object	This is bigger than a shoe.	This is smaller than a shoe.
	Orange object	This is more heavy than an apple.	This is less heavy than an apple.
	Bucket	There are two oranges in the bucket.	There are four oranges in the bucket.
Life Science	Animal that looks like a chubby frog	This lives in trees.	This lives in the ground.
	Animals that looks like a possum	This sleeps only at night.	This sleeps only during the day.
	Animal that looks like an armadillo	This has many sharp teeth.	This has no teeth.
Words	Orange object	This is called a wug.	This is called a dax.
	Pink and green object	This is called a toma.	This is called a mido.
	Blue and yellow object	This is called a dawnoo.	This is called a blicket.

Figure 1

Two informants with a familiar object for the "Life Science" domain.

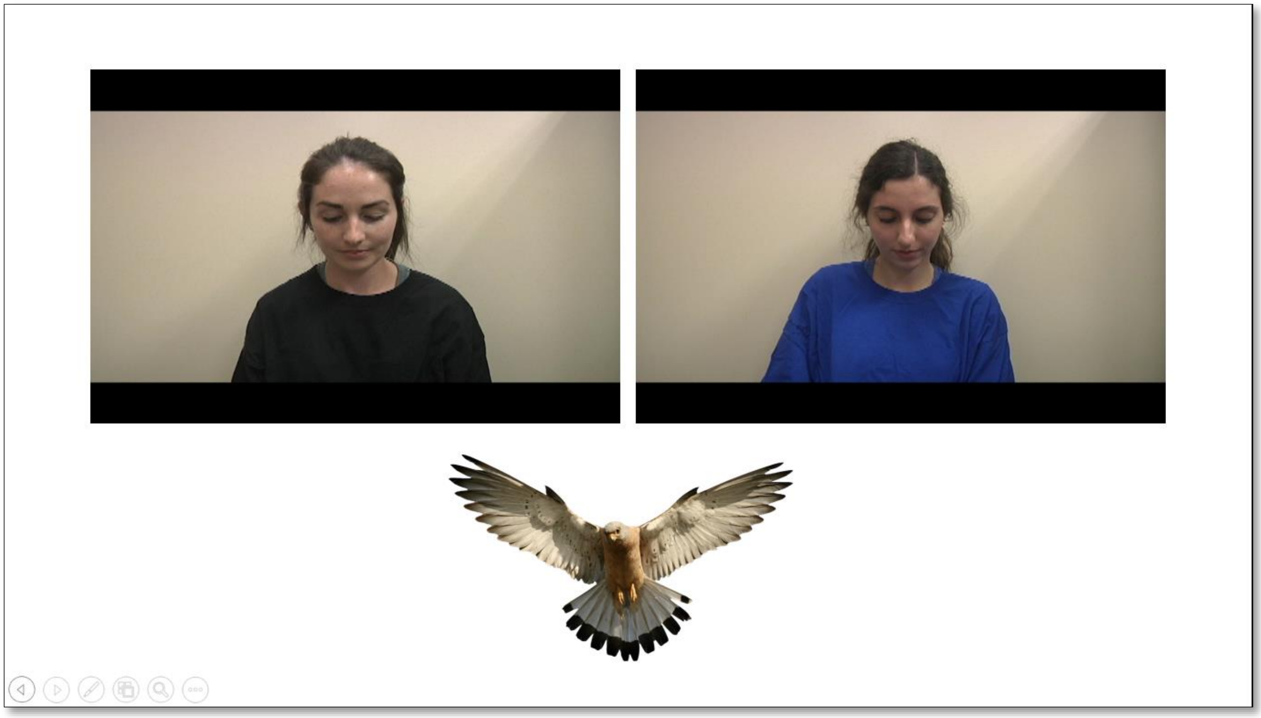
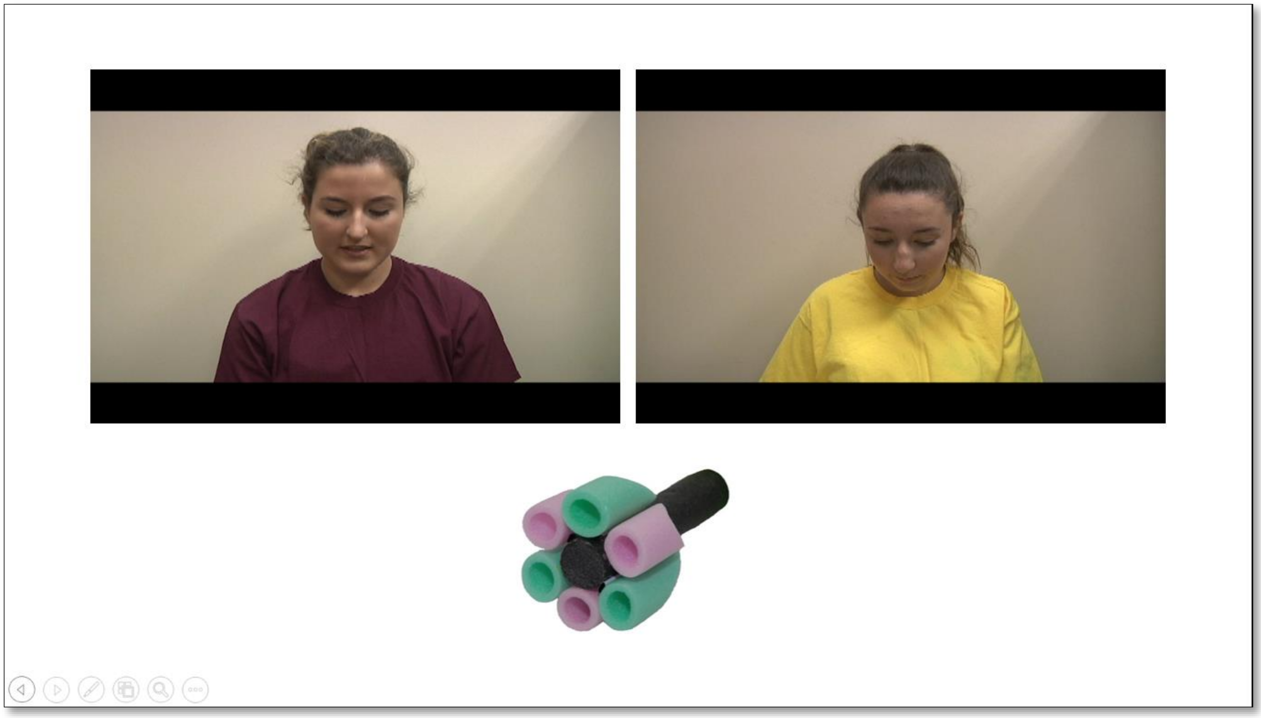


Figure 2

Two informants with a novel object for the "Words" domain



IRB Approval

THE UNIVERSITY OF ALABAMA | *Office of the Vice President for* Research & Economic Development Office for Research Compliance

March 25, 2019

Jason Scofield, Ph.D.
Associate Professor
Department of Human Development & Family Studies
College of Human Environmental Sciences
The University of Alabama
Box 870160

Re: IRB # 18-OR-117-R1 "Children's Information Sharing"

Dear Dr. Scofield:

The University of Alabama Institutional Review Board has granted approval for your renewal application. Your renewal application has been given expedited approval according to 45 CFR part 46. Approval has been given under expedited review category 7 as outlined below:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

The approval for your application will lapse on March 24, 2020. If your research will continue beyond this date, please submit a continuing review to the IRB as required by University policy before the lapse. Please note, any modifications made in research design, methodology, or procedures must be submitted to and approved by the IRB before implementation. Please submit a final report form when the study is complete.

Please use reproductions of the IRB approved parental permission and child assent forms to solicit permission of the parents and assent of the child.

Good luck with your research.

Sincerely,

[redacted]
Director & Research Compliance Officer

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