THE PENNSYLVANIA STATE UNIVERSITY
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DEPARTMENT OF COMMUNICATION SCIENCES AND DISORDERS

# INSTRUCTING NOVEL NAMES TO A CHILD WITH DOWN SYNDROME USING PRINCIPLES OF FAST MAPPING

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# ABSTRACT

Fast mapping is a phenomenon in which children rapidly acquire language based on a limited number of exposures. Children accomplish fast mapping through exclusion, or choosing novel things over familiar things when given a novel referent. In this study, we examined whether exclusion will be effective as a means of instruction to teach a young boy with Down syndrome novel animal names. We used a computer program to design various teaching sessions that contain unknown animals contrasted with known animals. With this program, we tested his ability to a) correctly choose the animal's name given a photograph of the animal b) choose the animal's photograph given the name c) generalize the animals' photographs, and d) remember the animals over an extended period of time.

TABLE OF CONTENTS

Abstract…………………………………………………………………………………………………………………… i
Acknowledgments……………………………………………………………………………………………………… iii

Chapter 1. INTRODUCTION…………………………………………………………………………………… 1
The Basics of Fast Mapping……………………………………………………………………………… 1
Proposed Mechanisms Underlying Fast Mapping……………………………………………… 2
Fast Mapping in Children with Atypical Development………………………………………… 5
Exclusion as a Means of Instruction……………………………………………………………… 8
Research Goals………………………………………………………………………………………………… 10

Chapter 2. METHOD…………………………………………………………………………………………… 11
Participant…………………………………………………………………………………………………… 11
Stimuli/Materials………………………………………………………………………………………… 11
Environment………………………………………………………………………………………………… 12
Trial Types…………………………………………………………………………………………………… 12
Refinement of Trial Structure………………………………………………………………………… 17
Reinforcement and Cueing……………………………………………………………………………… 18
Detailed Trial Types for One Set: Marten, Okapi, Tapir…………………………………… 18

Chapter 3. RESULTS…………………………………………………………………………………………… 20
Instruction and Outcomes……………………………………………………………………………… 24
Maintenance………………………………………………………………………………………………… 26

Chapter 4. DISCUSSION……………………………………………………………………………………… 27
Evidence of True Learning……………………………………………………………………………… 27
Maintenance ………………………………………………………………………………………………… 28
Limitations and Future Studies……………………………………………………………………… 29

References……………………………………………………………………………………………………… 31

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# INTRODUCTION

## *The Basics of Fast Mapping*

Although still in the process of developing basic memory and pragmatic skills, the average toddler accumulates more than 500 words before the age of 3 years (Ramachandra, Rickenbach, Ruda, LeCureux, & Pope, 2009). One explanation of this developmental trend is an individual's emerging ability to fast map. The process of fast mapping refers to the rapid acquisition of novel vocabulary based on a limited number of exposures and no direct instruction (Ramachandra et al., 2009). The initial result of fast mapping may be an incomplete or inaccurate idea of the word's meaning which the child can update and change according to successive encounters with the word (Dollaghan, 1987). Fast mapping has been observed in children as early as 13 months of age. These observations include children who are typically developing, as well as children with Specific Language Impairments, Williams syndrome, or Down syndrome (Gershkoff-Stowe, & Hahn, 2007).

Carey and Bartlett (1978) first documented this phenomenon of fast mapping in a study with fourteen 3-year-old participants. When told to "bring me the chromium tray; not the blue one, the chromium one," all children mapped the unknown color term by excluding the familiar color (Gershkoff-Stowe, & Hahn, 2007). In the following ten weeks, the children were assessed for the comprehension and production of "chromium." More than half of the children mapped "chromium" by adding the word to their lexicon as a color. These children were also able to produce the word in different contexts than they originally learned it. They likely mapped "chromium" as a color because of contrasting, when the teacher said “not the blue one, the chromium one,” and also because the two trays only differed in color (Carey, 2010).

*Proposed Mechanisms Underlying Fast Mapping*

A number of theories have been proposed to account for how children fast map. Learning meanings of words can be overwhelming and difficult when considering all possible meanings of any novel label. For instance, when an adult points to a car and labels it, the adult could be talking about a part of the car, the material, color, shape, size, or any number of characteristics about the car. Therefore, Markman (1992) argued that children use constraints on hypotheses to narrow the possible meanings of words. Merriman and Bowman (1989) argued that children demonstrate a *disambiguation* effect, or an inclination to choose unknown things over known things when presented with novel referents. Exclusion is synonymous with disambiguation, which is similar to fast mapping but does not imply a limitation on the number of exposures like that of fast mapping.

Exclusion emerges around age 2 and aids children in narrowing down the nearly infinite number of possible meanings of a word (Wilkinson 2005). Constraints such as the mutual exclusivity assumption, lexical gap-filing bias, contrast, novel name-nameless category, whole-object assumption, and taxonomic assumptions are proposed mechanisms that may aid in exclusion and word learning (Markman 1992).

The mutual exclusivity (ME) assumption states that children believe objects may only have one label, which guides children to reject novel names for already known objects (Markman, 1992). Markman and Watchel (1988) found that 3- and 4-year-old children use ME to learn names for parts of an object or substances. When a novel referent was mentioned in the presence of a known object, children rejected the novel referent as a synonym and interpreted it as a part of the known object, or the object's substance. ME can also help children narrow overextensions. For instance, if a child overextended *dog* to also label sheep but then learned the name for sheep, the child would stop calling the sheep a *dog* in order to preserve ME (Markman, 1992).

The lexical gap-filling bias states that children are motivated to acquire names for things with unknown labels (Merriman and Schuster, 1991). Therefore, the same effect of exclusion would result without the principle of mutual exclusivity. The difference in the lexical gap-filling bias lies in that children would be choosing the novel object as the novel referent because they desire to name novel objects, not because they reject synonyms for objects (Markman, 1992).

Clark's (1988) principle of contrast states that "every two forms contrast in meaning." When a child hears a new referent, he is motivated to find the meaning and assumes that the speaker is naming something without a name. Contrast differs from ME because contrast predicts that the new reference may be part of an object, or another name for a known object.

Golinkoff & Hirsh-Pasek (1992) argued that contrast does not narrow the child's choices for possible word meanings, making lexical acquisition more difficult. The novel name-nameless category principle (N3C) states only that novel names will be mapped onto unnamed categories. When given a novel referent and presented with both a known and unknown object, the child will choose the unknown object. N3C differs from contrast and ME because it does not reject the acquisition of synonyms and does not require all objects to have only one name (Golinkoff & Hirsh-Pasek, 1992). The lexical gap-filling bias differs from N3C because it posits that children have an innate motivation or desire to name unknown objects.

There are several word learning strategies that children likely use when encountering a new word, through fast mapping or other means. The whole-object assumption is significant to understanding how children organize meanings of words after fast mapping. As mentioned earlier, when adults label an object, the novel label could refer to part of the object, or any other trait about the object. According to the whole-object assumption, children constrain these possible meanings by assuming that novel labels refer to whole objects, instead of its parts or other properties (Markman, 1992).

Children also exhibit taxonomic assumptions, opposed to thematic relations, when extending newly learned words to other objects or meanings. Markman and Hutchinson (1984) tested this hypothesis by asking children to choose two related things from: dog, cat, and dog food. The children often chose dog and dog food as related things. If the dog was called a “dax” and the children were asked to “find another dax,” the children likely chose the cat. This demonstrates that when children learn new words, they focus on taxonomic relations to extend meanings (Markman, 1992).

*Fast Mapping in Children with Atypical Development*

The studies mentioned above, as well as others, have focused on the different theories regarding how typically developing (TD) children learn new words through fast mapping or exclusion. This raises the question: does fast mapping prove successful for atypically developing children who suffer from delayed or disordered language learning?

Dollaghan (1987) conducted a study to examine and compare fast mapping skills of children without disabilities, with those of children with language impairments. Participants included 11 typically developing children and 11 children with language impairments (ages 4:0- 5:6) who demonstrate expressive syntactic deficits. There were a total of five tasks (exposure, comprehension, production, recognition, location) that the experimenters tested in the form of a game involving a puppet. The stimulus was an oddly-shaped, white, plastic ring, referred to as a nonsense word *koob* (/kub/).

During the exposure task, participants were instructed to hide a pen, fork, and *koob* from the puppet. First the pen and fork were hidden one at a time, which left the experimenter to ask the child to "hide the *koob*." The comprehension task required the child to feed the puppet the *koob* from an array of a fork, and two other oddly shaped objects that were physically dissimilar from the *koob*. During the production task, the children were asked to produce the word *koob* upon the experimenter holding up the object and requesting the label. If the participant was able to say at least two of the three phonemes, the response is considered correct. A recognition task was only given if the participant did not attempt to produce the word in the production task. The experimenter held up the *koob* and asked the child to identify if it was a "*koob*, soob, or teed." The location task required the child to identify where the *koob* was hidden in the exposure task. The purpose of this task was to test whether the child had remembered nonlinguistic contextual information about the *koob*.

The two groups differed in only the production and recognition assessments. Seven out of eleven children from the TD group were able to produce *koob*, while only one out of eleven children from the language-impaired group could. Two of two children from the TD group were able to recognize *koob* while only two of three children from the language impaired group could. Still, in the exposure (11 of 11), comprehension (nine of 11), and location (eight of 11) assessments, both groups displayed the same results. Despite low results in production, the group of children with language impairments was able to immediately make the appropriate reference to the unfamiliar label, comprehend the nonsense word, and remember its location equally as well as the TD group. Dollaghan speculated that children with language-impairments are less skilled in perceiving phonemes in novel words. Other explanations could disclose deficits in storing phonological information into memory, or a retrieval deficit of adequately stored phonological information (Dollaghan 1987).

Wilkinson (2005) compared word learning performance of 11 participants with intellectual disabilities to a control group of 11 typically developing children with corresponding receptive vocabulary scores. This study examined the differences in using the concurrent versus successive introduction procedure to teach new words to TD children and those with disabilities.

Six color photographs (dog, cat, banana, apple, tree, and chair) represented the familiar objects and served as baseline to the four novel objects with nonsense labels (rutch, neeg, kice, bood). Three photographs were presented one at a time on a touch-screen computer and the child was instructed to select the spoken word.

This study sought to examine whether the concurrent introduction procedure or the successive introduction procedure was more successful in resulting in learning by TD children and children with atypical development. The concurrent procedure introduces one novel stimulus at a time, never showing two novel objects in the same trial until the testing for learning outcomes. The successive procedure introduces the first novel stimulus next to two known objects, but introduces the second novel stimulus next to the first novel stimulus and a known object. The successive procedure requires the participant to learn the first novel stimulus and contrast it with the second novel stimulus.

In exclusion trials, which the authors labeled “disambiguation” trials, the mean number of errors for participants with intellectual disabilities was 1.62 (median=1) while the mean was 0.91 for control participants. However, in the learning outcome trials, participants with intellectual disabilities performed significantly lower than the control group in both concurrent and successive procedures. Therefore, the basic exclusion process for both procedures is intact in the children with intellectual disabilities, but they exhibit a discrepancy in the amount of learning compared to that of TD children.

For both groups, successive introduction yielded better performance than concurrent introduction. In the control group, all children benefitted from successive introduction. Yet, for some in the intellectual disabilities group, successive introduction did not lead to higher performance. The developmentally more mature group excelled with successive introduction but the developmentally younger group performed at low levels regardless of the procedure. When the group with intellectual disabilities was divided by etiology, individuals with Down syndrome performed better with successive (90%) rather than concurrent (72%) introduction with regards to the learning outcome trials. Individuals with nonspecific intellectual disabilities followed the same trend with higher results with successive (80%) rather than concurrent (58%). On the contrary, individuals with autism spectrum disorders performed better with concurrent (85%) rather than successive (70%).

This study exhibits that individuals with intellectual disabilities are able to perform exclusion on the basis of novelty; however, that experience does not always result in the same level of learning as TD children. The cause for this less successful learning is unknown, yet perhaps finding the cause will aid in true learning, as successful exclusion behavior is not as valuable if no learning results from it.

*Exclusion as a Means of Instruction*

Wilkinson and Albert (2001) conducted a study to incorporate adaptations in exclusion in order to use it as an effective means of instructing sight-word recognition to two learners. As in Wilkinson (2005), Wilkinson and Albert (2001) used both the successive and concurrent introduction procedures for two participants: Dana and Lynn, respectively. Dana was an 8-year-old girl with autism and intellectual disability and tested at age equivalent of 2:0 on the Peabody Picture Vocabulary Test-Revised (PPVT-R). Lynn was a 14-year-old girl with Down syndrome and intellectual disability and had an age equivalent on the PPVT-R of 5:4. Dana was tested at a table and Lynn was tested at a computer with an experimenter at her side.

Dana's initial results from the successive procedure were poor, therefore, they increased the number of teaching sessions from 3 to 4 (session 4 was a repeat of session 3). Her outcomes increased from 50-67% accuracy to 100% accuracy. In contrast, Lynn received the concurrent introduction procedure because she displayed learning through both procedures and the concurrent introduction is more concise.

Both participants' teaching programs were tailored to their individual needs and vocabulary selection. Dana's target words were grouped into sets of three in which the words did not start with the same letter and were in similar categories. Lynn's words were introduced serially and were essentially grouped into one large set. Dana successfully disambiguated with a mean accuracy of 99% and Lynn demonstrated virtually no errors during learning. Dana's mean preteaching accuracy was 37% and the mean post teaching accuracy was 98% and Lynn's post-test accuracy (mean= 97%) was also significantly better than her pretest (mean= 37%). Dana also performed virtually errorlessly when tested for maintenance of learning across time, each time scoring higher than 95% accuracy. She also displayed generalization learning by accurately matching spoken to written word in the classroom.

This study exhibits that exclusion procedures can be successful in teaching individuals with intellectual disabilities and results in true comprehension. Also, in order to teach successfully, exclusion must be adapted to each individual learner. This study also displays that learning occurred regardless of stimulus type (spoken words, written words, picture communication symbols (PCS), and color photographs) even when the learner has little to no knowledge about the various symbol types. The methods used in our current study were developed from methods used in Wilkinson and Albert (2001).

*Research Goals*

It is apparent that abilities to fast map and perform exclusion are intact in children with intellectual disabilities. Yet, it is more difficult for many children with disabilities to acquire language in the same way as children without disabilities and their communication skills may hinder due to this lag. Instructing a child to memorize vocabulary may be ineffective, quickly forgotten, and mentally fatiguing. How do we help children with intellectual disabilities learn and expand their language skills in a natural and non-laborious manner?

Because children with disabilities have demonstrated effective fast mapping abilities, exclusion could provide a rapid and effective means of language intervention for atypically developing children. Regardless of the specific processes that motivate or guide children to fast map, the studies reviewed above (Carey & Bartlett 1978; Wilkinson and Albert, 2001) demonstrate that exclusion can be removed from its natural context and recreated as a means of teaching children target words. This study examined the effectiveness of exclusion as a teaching tool for instructing novel animal names to a child with Down syndrome.

# METHOD

*Participant*

JNL was a seven-year-old male with a diagnosis of Down syndrome. His Peabody Picture Vocabulary Test-Revised (PPVT-R) was 3:6. JNL's full scale IQ score was 59, or 0.30 percentile according to the Wechsler Preschool and Primary Scale of Intelligence Test (see table 1). He attended 1st grade in a mainstream classroom and had been receiving speech and language services since infancy.

Table 1

| Scale | Score | Percentile Rank |
|---|---:|---:|
| Verbal | 61 | 0.50% |
| Performance | 59 | 0.30% |
| Processing Speed Quotient | 71 | 3% |
| Full Scale | 59 | 0.30% |

*Stimuli/Materials*

Stimuli were color photographs of familiar (baseline) and unfamiliar (novel) animals obtained from the internet. For each set of trials, there were six baseline animals and three novel animals (with the exception of the six target animals maintenance trials). Baseline animals were common animals that were suspected to be familiar to most people. The novel animals were rare animals that would likely be unknown to most people. JNL was pretested to ensure that he could reliably select the photographs of the familiar animals when presented with the written label as well as his unfamiliarity with the novel animals, as indicated by chance levels of responding. Based on this pretesting (described below), twelve novel animals were identified and divided into sets of three. The final sets of novel target animals to be taught included: (a) Set 1- martin, tapir, okapi; (b) Set 2- baiji, tamarraw, kiwi; (c) Set 3- barracuda, sea urchin, horseshoe crab; (d) Set 4- manatee- sea cucumber, chimerafish. All stimuli were presented on a Macintosh laptop through the matching-to-sample (MTS) program—an automated, preprogrammed software developed for this and related research (Wallace, 2010, based on Dube, 1991).

*Environment*

JNL was tested each week in his own home with an experimenter at his side. The trials were in the form of receptive matching tasks. The computer controlled the display and recorded JNL's answers. There was a picture or written word (depending on the trial type) at the top of the screen and three pictures or words at the bottom. JNL was instructed to select one of the bottom three choices that corresponded with the picture or word at the top of the screen by clicking with a mouse.

*Trial Types*

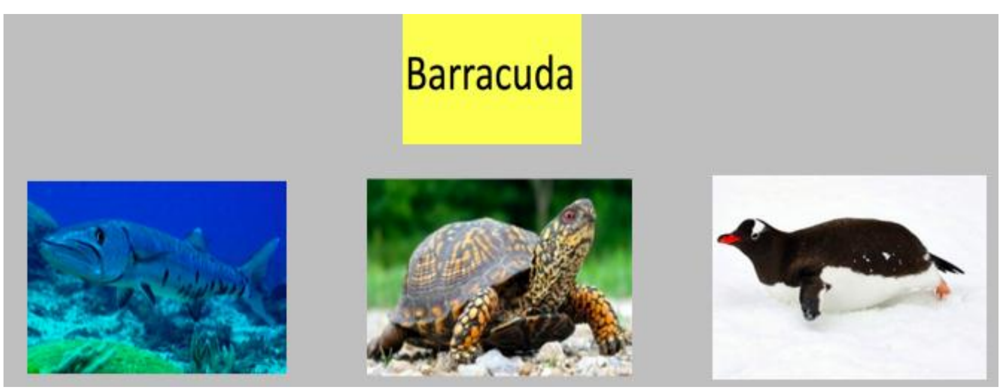
Within each set, there were four sessions of trials: pretest, exclusion, outcome/symmetry, and generalization.

*Pretest*. All of the pretest trials were presented with a written animal name at the top of the screen with three pictures of animals at the bottom. Baseline trials presented three animals that the experimenter expected JNL had already learned, while probe trials for targets presented three animals that the experimenter expected JNL might not respond to reliably.  JNL's performance on the pre-test was used to select the stimuli for later testing. Animals which JNL selected reliably became the baseline animals, and those on which JNL showed chance-level selections became the novel targets. Each item was presented as the target choice on one trial but as a potential choice on three trials (thus, there were a total of three opportunities to respond to each animal, all together).

*Exclusion Trial Using Successive Introduction Procedure.* During these trials, the participant began the learning or "mapping" the novel animals by means of exclusion. All of the exclusion trials were structured with a written animal name at the top of the screen with three pictures of animals at the bottom (see figure 1.1). Novel animals were all introduced using successive introduction (Wilkinson & Albert, 2001).

In this successive introduction procedure, the first novel animal is contrasted against two known animals. If exclusion is operational, the participant will select the novel animal which corresponds with the unfamiliar label. This follows the traditional method of exclusion and will be referred to as exclusion word 1 (Ex W1).

Figure 1.1 Novel animal #1: Barracuda (Ex W1)

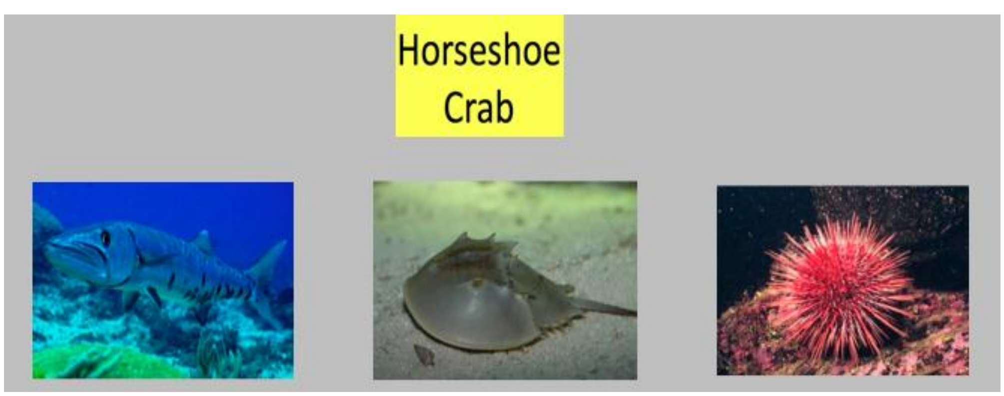


The second novel animal is introduced using a modified exclusion (MEx W2) strategy. Rather than contrasting the second novel animal with two known animals, it is contrasted against one familiar animal and the first novel animal (see figure 1.2), which should now be somewhat familiar. This successive introduction procedure encourages the learner to differentiate between the novel animals.

Figure 1.2 Novel animal #2: Sea Urchin (MEx W2)


Likewise, the third novel animal is introduced using the modified exclusion (MEx W3) strategy and is contrasted against the first and second novel animal. At this point, the participant must distinguish among all three novel animals (see figure 1.3).

Figure 1.3 Novel animal #3: Horseshoe Crab (MEx W3)



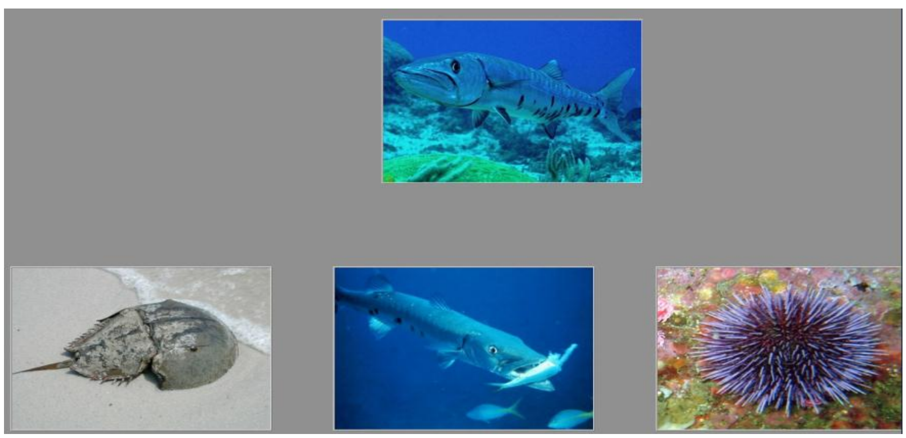
*Outcome Trials.* Outcome trials tested whether the participant successfully mapped and retained the novel animals from the exclusion trials. These outcome trials were similar to the structure of exclusion trials, with the written name at the top of the screen, and three pictures at the bottom. Though the trial structure appears similar to that of MEx W3, the participant's task is more difficult because he can no longer choose correctly simply by selecting the most recently introduced novel animal. That is, in MEx W3, the most recently introduced novel animal is always the correct choice. This is not true during an outcome trial, and the participant must now be able to alternate choosing among all three novel animals, which tests true learning.

*Symmetry Trials*. The structure of the symmetry trials was flipped from that of the exclusion and outcome. In the symmetry trials, a picture of the target animal is at the top of the screen, and three written animal names are at the bottom (see figure 2). Now the participant must select one of the three written words that correspond with the picture at the top. These symmetry trials tested whether the participant can successfully map the written word to the picture, opposed to only the picture to the word. Symmetry trials appeared in the same session as the outcome trials.

Figure 2: Symmetry trial

*Generalization Trials*. All of the generalization trials (except set 4) began with six outcome trials, which allow JNL to restore his memory of these novel animals. Then, the trial structure shifts to a photo of the target animal at the top and three photos at the bottom (see figure 3). The pictures at the bottom are different exemplars of the same species of animals already seen in this set. For instance, the answer choices for the target animal “marten” would include new pictures of “okapi,” “marten” and “tapir.” This tested whether the participant can extend his knowledge of the novel animals and generalize new photos of the same species.

Figure 3- Generalization trial



The exclusion session may be referred to as a teaching session while the outcome/symmetry and the generalization sessions may be collectively referred to as outcome sessions, as both sessions test JNL’s learning outcomes.

*Refinement of Trial Structure*

The trial structures of set 1-4 were refined in order to accommodate for a more efficient teaching strategy. Therefore, sets 1-4 contain sessions which differ in small ways from one another in trial structure. Trials that proved unnecessary for efficient learning were removed from various outcome sessions.

*Reduction of Reminder and Outcome Trials*. From set 1 to set 2, the outcome trials became more difficult as they no longer start with two reminder trials. By removing reminder trials, we came closer to identifying how efficient and quick JNL could perform exclusion. From set 3 to set 4, three reminder trials were removed from generalization trials. The number of outcome trials from set 3 to set 4 also decreased by three in order to increase efficiency.

*Refinement of Generalization Sessions.* From set 3 to set 4, the generalization trials also increased in difficulty, as the trials all contain three novel animals in the answer choices. In previous sets, generalization trials began with six trials which contained only one or two novel animals in the answer choices, before progressing to trials with all three novel animals in the answer choices.

*Maintenance of Previously Taught Novel Animals.* After learning sets 1 and 2, JNL was tested for the maintenance of all six novel animals. A file was created which incorporated all six novel animals in which animals from set 1 were interspersed with animals from set 2 and tested with outcome, symmetry, and generalization trials.

The novel animals from set 3 (barracuda, sea urchin, horseshoe crab) served as baseline animals for set 4. This tests whether the participant can keep recently learned animals in memory while learning new animals.

*Reinforcement and Cueing*

A short musical tone played upon selection of the correct answer. No sounds played upon selecting an incorrect answer. The experimenter gave JNL cues, such as reading the word for him or repeating the animal's name. She also gave him verbal praise, such as "good job" or "good remembering," after every few trials. A cueing hierarchy was developed to track the number and level of cues the participant received from the experimenter (see Table 2).

Table 2

| Cue Level | Cue Descriptions | Cue Code |
|---|---|---|
| Low | A repeats C's spontaneous production<br>A points to sample stimulus | 0.5<br>1 |
| Medium | A asks what the sample stimulus is<br>A points and asks what the sample stimulus is | 1.5<br>2 |
| High | A labels the sample stimulus<br>A points to and labels that sample stimulus | 2.5<br>3 |

*Detailed Trial Types for One Set: Marten, Okapi, Tapir*

Table 2 displays the various trial types within a session. The "sample" represents the target photograph or written word at the top of the screen. When the animal name is in quotations, it signifies that the sample or answer choice was the written word of that animal. When there are no quotations around the animal name, the sample or answer choice is a photograph of that animal.

All novel animals are bolded in the answer choices. This exhibits the difficulty level of each specific trial type—the more novel animals in the answer choices, the more difficult the trial.

Table 2

*Teaching/Outcome for Set 1: Martin/Okapi/Tapir*

| | | | Photograph comparisons (examples only) | | |
|---|---|---|---|---|---|
| Session Type | Number of trials/type/order | Sample | 1 | 2 | 3 |
| Session 1: Pretest | 15 Baseline (interspersed) | "turtle" | turtle | cow | dolphin |
| | 6 Exclusion | "marten" | **marten** | **tapir** | **okapi** |
| Session 2: Exclusion | 13 Baseline (interspersed) | "horse" | horse | tiger | penguin |
| | 6 Exclusion marten (interspersed) | "marten" | **marten** | cow | turtle |
| | 2 Exclusion marten (interspersed) | "marten" | **marten** | **tapir** | penguin |
| | 5 Exclusion tapir (interspersed) | "tapir" | **tapir** | **marten** | horse |
| | 2 Exclusion okapi | "okapi" | **okapi** | **marten** | **tapir** |
| Session 3: Outcome | 13 Baseline (interspersed) | "penguin" | turtle | penguin | tiger |
| | 1 Exclusion (reminder) martin | "marten" | **marten** | turtle | horse |
| | 1 Exclusion (reminder) tapir | "tapir" | **tapir** | **marten** | cow |
| | 1 Exclusion (reminder) okapi | "okapi" | **marten** | **tapir** | **okapi** |
| | 3 Outcome marten (interspersed) | "marten" | **marten** | **tapir** | **okapi** |
| | 3 Outcome tapir (interspersed) | "tapir" | **marten** | **tapir** | **okapi** |
| | 3 Outcome okapi (interspersed) | "okapi" | **marten** | **okapi** | **tapir** |
| | 1 Symmetry okapi | okapi | **"okapi"** | **"marten"** | **"tapir"** |
| | 1 Symmetry marten | marten | **"marten"** | **"okapi"** | **"tapir"** |
| | 1 Symmetry tapir | tapir | **"tapir"** | **"okapi"** | **"marten"** |
| Session 4: | 1 Exclusion (reminder) marten | "marten" | **marten** | cow | penguin |
| | 1 Exclusion (reminder) tapir | "tapir" | **tapir** | horse | tiger |
| | 1 Exclusion (reminder) okapi | "okapi" | **marten** | **tapir** | **okapi** |
| | 4 Generalization marten (interspersed) | marten | **marten** | **okapi** | **tapir** |
| | 4 Generalization tapir (interspersed) | tapir | **tapir** | **okapi** | **marten** |
| | 4 Generalization okapi (interspersed) | okapi | **okapi** | **tapir** | **marten** |

# RESULTS

*Figures 4.1 to 4.4 present the overall accuracy of selections for each trial type, across the four replications of the procedures. Figures 5.1 to 5.4 provide additional detail about each session, including the total number of each trial type in each session, the number of correct selections for each trial type, and the session duration. The asterisks highlight occasions on which one or more errors occurred. Also, the average level of cueing for each session is listed above each bar.*

Figure 4.1

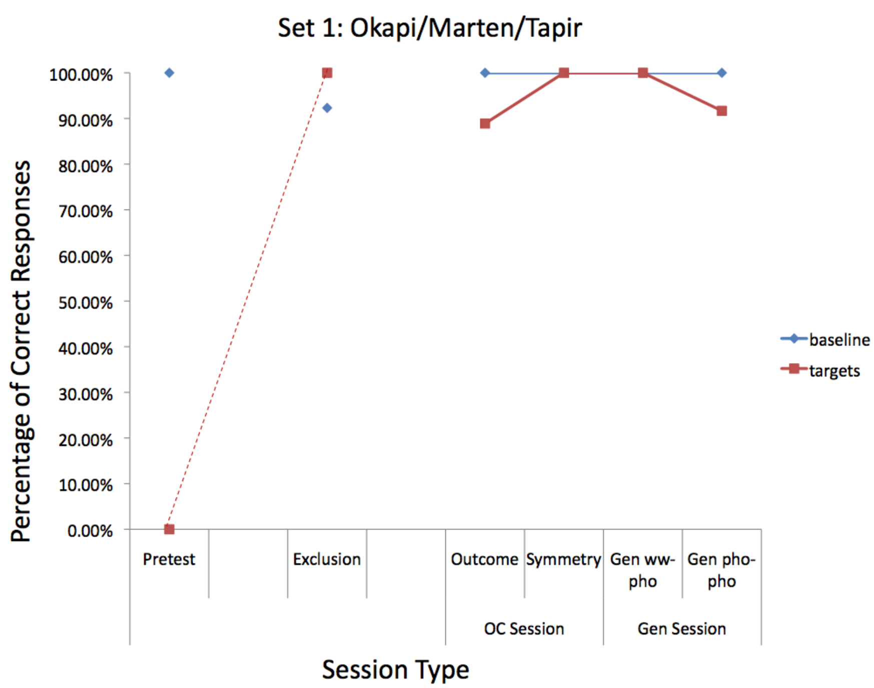


Figure 4.2

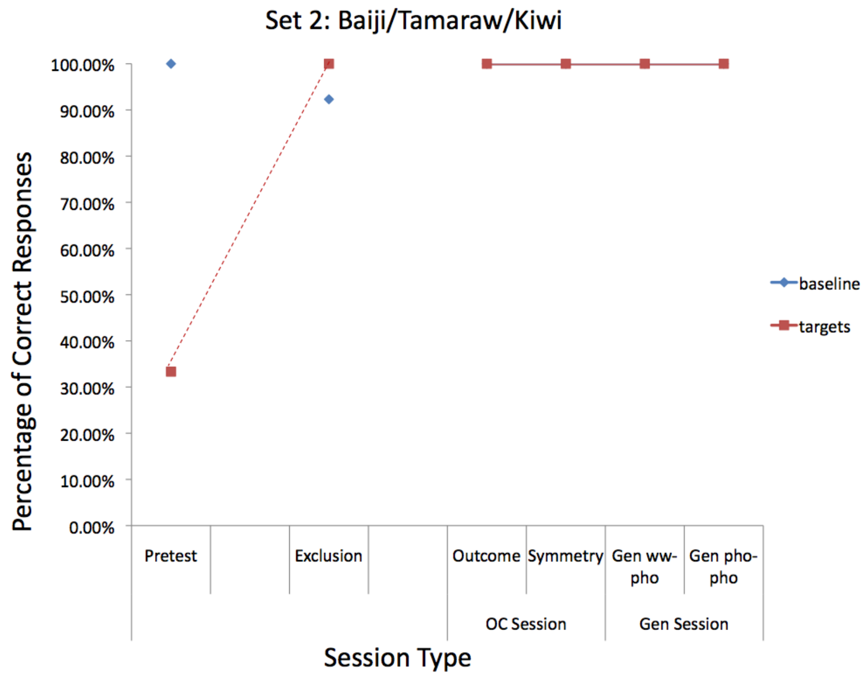



Figure 4.3

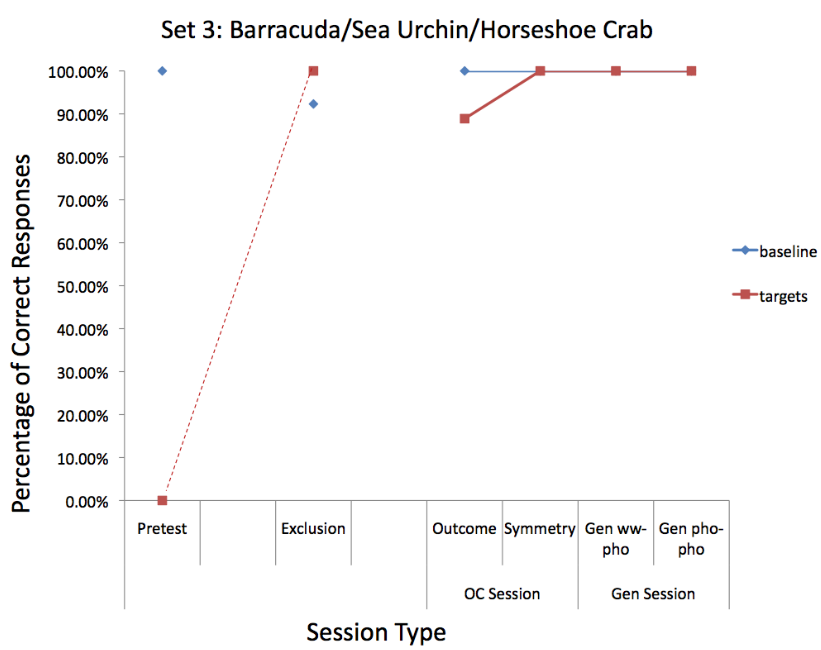


Figure 4.4

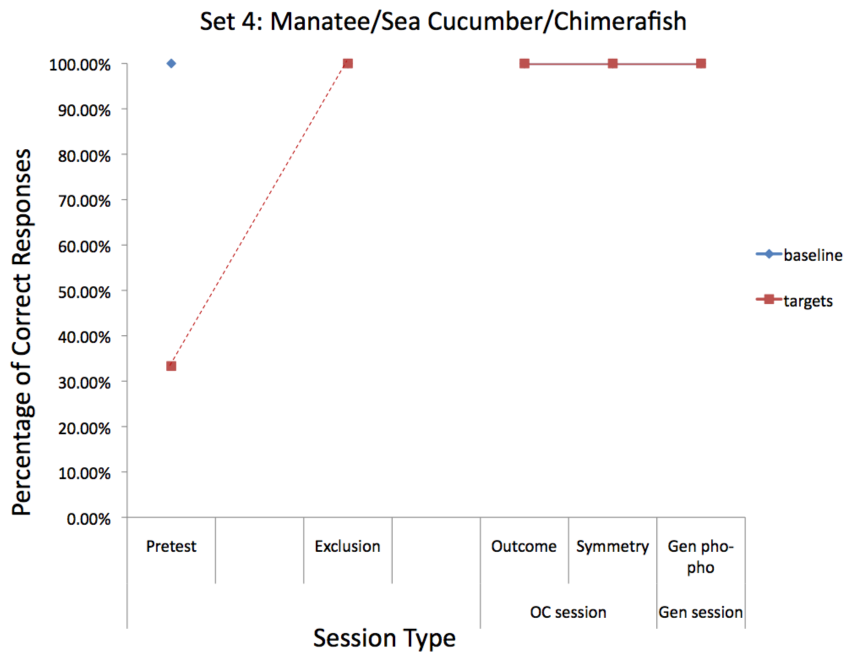



Figure 5.1

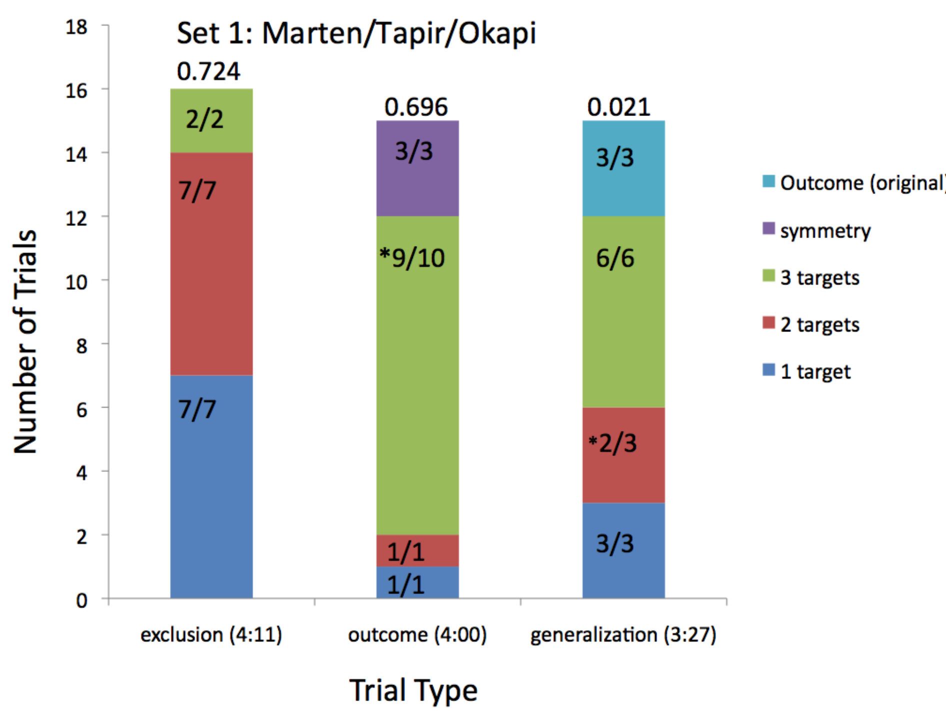


Figure 5.2

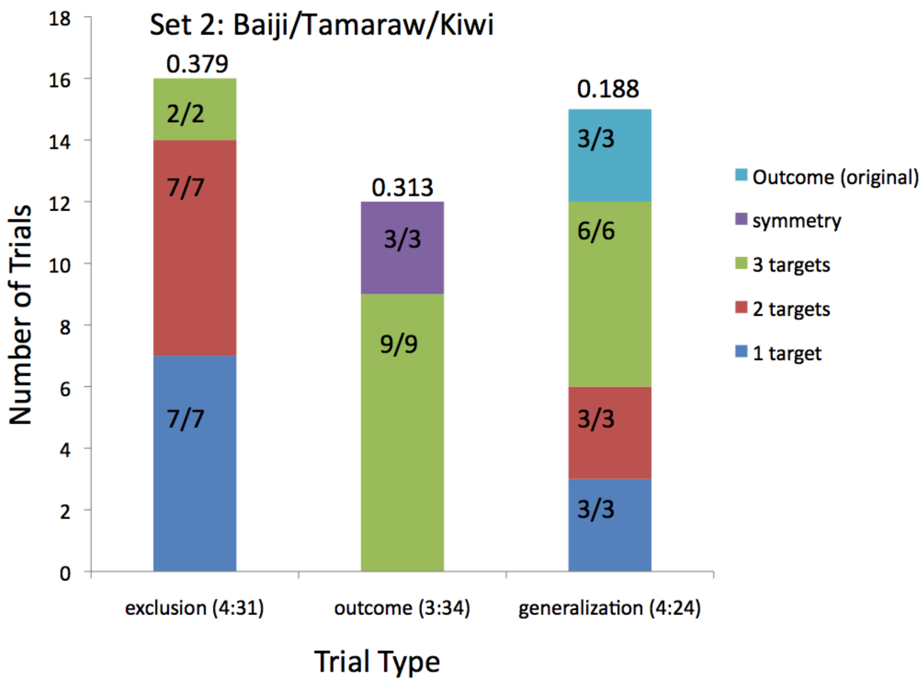



Figure 5.3

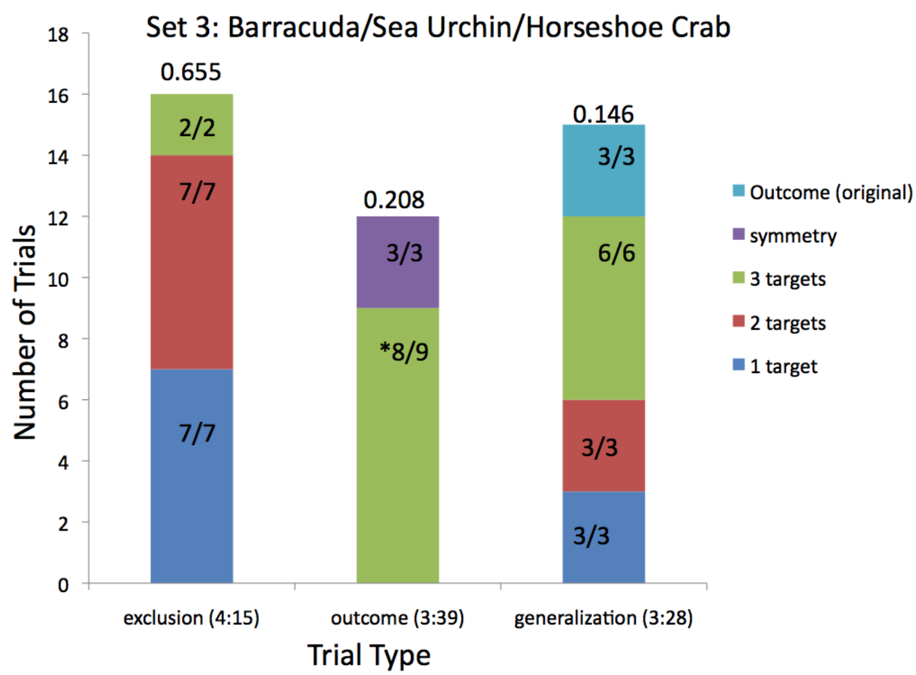
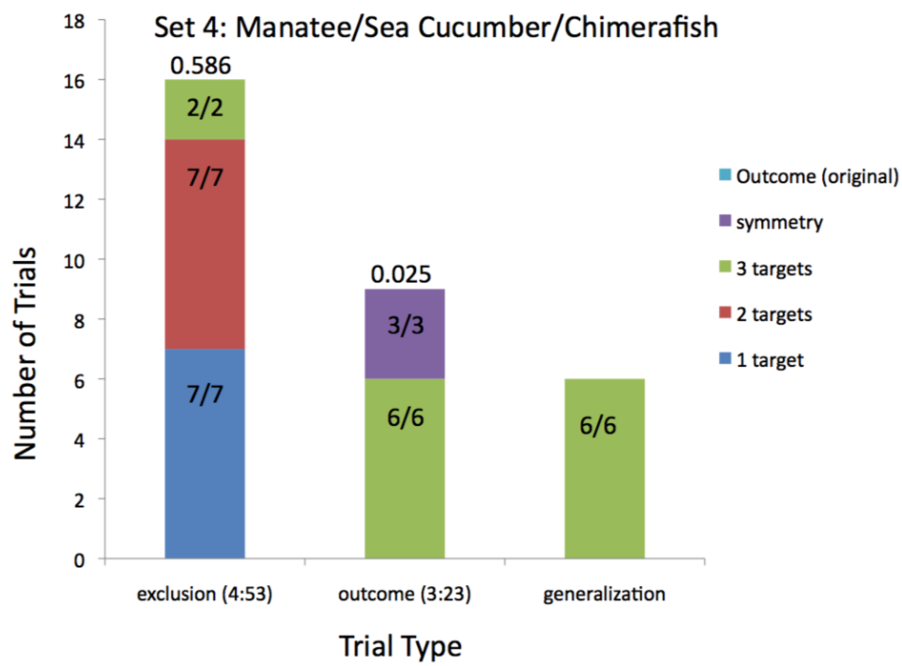


Figure 5.4




*Instruction and Outcomes*

*Pretest.* In sets 1 and 3, JNL tested at 0% accuracy on the targeted novel animals and at 100% accuracy on the baseline animals. In sets 2 and 4, JNL tested at 33.3% accuracy on the targets and at 100% accuracy on baseline animals. However, because there were three answer choices, a score of 33.3% reflects chance level of performance and suggested the target animals were unfamiliar to JNL.

*Exclusion*. JNL completed the exclusion session one week after pretesting. In all sets, JNL tested at 100% accuracy on the targeted novel animals. JNL received no exposure to the novel animals since the pretest a week before, but immediately learned all three animals. Each exclusion session included twenty-nine trials, and the mean duration for all four exclusion sessions was 4 minutes, 28 seconds. The mean level of cueing provided for all four exclusion trials was 0.586. This number shows that JNL did not receive any cueing for the majority of the trials. For those trials that he received cues, it was generally a small amount. This number indicates that cueing from the adult was generally repeating the child's spontaneous production or pointing to the stimulus, not labeling the stimulus for the child.

*Outcome/Symmetry.* In sets 1 and 3, JNL tested at 88.89% accuracy on the outcome trials and 100% accuracy on the symmetry trials. (An 88.89% reflects an incorrect response on one trial). In sets 2 and 4, JNL tested at 100% accuracy on both the outcome and symmetry trials. JNL underwent 18 outcome trials and six symmetry trials during the outcome/symmetry session. The mean duration was 3 minutes, 39 seconds, and the average amount of cues for all four outcome/symmetry sessions is 0.311.

*Generalization.* JNL scored 100% correct on the outcome trials within the generalization session in sets 1-3 (outcome trials were omitted from set 4). JNL tested at 91.67% accuracy on the generalization trials in set 1 and tested at 100% accuracy for the remaining three sets. (A score of 91.67% reflects an error on one trial). For sets 1-3, JNL underwent six reminder trials (structured as outcome trials) and eighteen generalization trials. In set 4, JNL underwent fourteen generalization trials. The mean duration of the generalization trials in sets 1-3 was 3 minutes, 46 seconds, and the mean amount of cueing is 0.118. Unfortunately, the generalization session from set 4 was not recorded correctly due to technical issues and therefore was not coded for cueing.

*Cueing and efficiency*. There was minimal cueing throughout sessions. All sessions were videotaped and coded, then verified by two researchers. As previously mentioned, the average amount of cues per session is listed above each bar in figures 5.1-5.4. The time necessary for one full set (four individual sessions) was less than 15 minutes for JNL.

*Maintenance*

*Six target animals combined.* All six novel animals were collectively tested one week after the completion of set 2. JNL tested at 91.66% (22/24) accuracy with target animals and at 100% (9/9) accuracy with baseline animals. JNL demonstrated his ability to retain and recall animals from set 1, of which he had not been given any exposure to for one month. His results also showed his ability to perform well with the integration of six target animals in one session, despite that JNL had never seen target animals from both sets compared against one another.

*Set 4*. The target animals from set 3 served as the baseline for set 4. The target animals from set 3 and set 4 were comprised of only sea creatures. Within set 4, JNL tested at 100% accuracy in all sessions across baseline and target trials. JNL was able to learn all three novel animals from set 4 without any confusion. Sea creatures from set 3 and set 4 shared similar physical characteristics, background images, and names (sea urchin in set 3, sea cucumber in set 4). JNL's results displayed his ability to maintain the previously learned sea creatures from set 3 and distinguish them from the novel sea creatures in set 4.

# DISCUSSION

JNL demonstrated rapid, errorless learning with minimal cues through exclusion instruction across four replications of the procedures. JNL also extended his learning beyond outcome trials and into symmetry and generalization trials. This study suggests that learning through exclusion can be effectively transferred to incorporate educationally relevant materials. JNL also demonstrated proficiency in maintenance of the previously learned animals in sets 1-3. This study supports the possibility of exclusion as a useful teaching tool to rapidly instruct novel animal names to a child with Down syndrome.

## *Evidence of True Learning*

The effectiveness and efficiency of exclusion learning can be seen through JNL's weekly testing schedule and his final results. For instance, results from the outcome sessions demonstrate that JNL mapped the novel animal names into his lexicon during the exclusion trials and retained them one week later with no exposures to the targets in between testing. Pretesting had verified that these novel animal names and images were unfamiliar to JNL until the exclusion instruction, yet he effectively learned and retained the animals' physical characteristics and names based solely on a computer-presented exclusion session which lasted approximately five minutes.

Results from the symmetry trials reveal that JNL bi-directionally mapped the written word to the photograph, as well as the photograph to the written word. Though the exclusion trials never flipped written word to photograph, JNL learned the animals proficiently enough that he could successfully map it the reverse from how he learned it. JNL's success in symmetry trials is significant, as poor results on symmetry tasks have been reported in previous studies with different participants (Fields, Adams, Newman, & Verhave, 1992).

For instance, O'Donnell and Saunders reviewed equivalence literature in individuals with mental retardation and language limitations. Equivalence tests are tests of symmetry, reflexivity, and transitivity. Multiple participants did not pass the symmetry equivalence tests despite displaying high accuracy on the baseline relations throughout testing. Therefore, children and adults with atypical development may have difficulty demonstrating accuracy in symmetry tasks so it was an important aspect to study (O'Donnell & Saunders 2003).

Moreover, results from the generalization trials displayed JNL's ability to broaden his previous knowledge and successfully generalize unfamiliar exemplars of animals of which he has only ever seen one exemplar. The animals in the new exemplars often varied in size, color, background image, and angle. In addition, the results from set 4 demonstrated that JNL can test at 100% accuracy for generalization trials without reminder trials.

*Maintenance*

*Six target animals combined*. JNL demonstrated his ability to retain and recall animals from set 1, of which he had not been given any exposure to for one month. His results also show his ability to perform well with animals from both set 1 and set 2, though he had never seen target animals from both sets compared with one another. In this session, JNL was successful in all trial types; outcome, symmetry, and generalization.

*Set 4*. Maintenance of set 3 was also seen when the target animals were used as baseline in set 4. JNL's retention of the target animals in set 3 proves strong in that he successfully discriminated between the two sets of similar sea creatures.

This study shows that exclusion can not only result in successful outcomes but can be extended to result in true learning that can expand to other aspects of language learning, such as generalization. Through the refinement of trial structure, we see that reducing the amount of trial numbers in a session may still produce successful results. Therefore, the successive introduction procedure can be more time efficient.

*Limitations and Future Studies*

Though we were able to obtain excellent results from JNL, these results are only from one child. To gain a more accurate conclusion on the effectiveness of exclusion, this study must be replicated using a larger sample size. In addition, the study would be more comprehensive if the sample were mixed with differing etiologies and participants of various ages. It would be interesting to see what age and etiology is most ideal for learning through exclusion.

Also, JNL was cooperative and enthusiastic about learning the animals' names. Therefore, the results for a less cooperative child may not be as strong, especially if the subjects being taught are uninteresting to the participant.

Another limitation is that JNL learned only the names and physical appearance of the target animals. He did not learn anything else that characterizes the animals, such as what areas of the world they live, what foods or animals they eat, how quickly they can move, or any other information about how they live. Our research team is compensating for this limitation by creating interactive, electronic books that teach JNL about these characteristics.

Future studies can also focus on testing more maintenance over a longer period of time. The studies could also test how well the participant can do without an experimenter by his/her side. The amount of cueing in this study was minimal and the results were not significantly affected by it. If an experimenter is not necessary, children could learn vocabulary by themselves with preprogrammed software similar to what was used in this study.

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