The Acquisition of Generalized Matching in Children With Developmental Delays

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Abstract

The purpose of this study was to assess the extent of a generalized matching repertoire. Three children, ranging from two to four years of age, were selected from an early childhood developmental delay classroom. They were taught identical matching with six objects. After the children mastered those six objects, they were tested for a generalized matching repertoire, and all three children demonstrated a generalized identical-object matching repertoire. One of the children was tested with two-dimensional picture cards and demonstrated a generalized two-dimensional matching repertoire. While the other two children were not formally tested, two-dimensional matching was specifically targeted as part of their individual curricula; and both children mastered two-dimensional matching so quickly as to suggest they had already acquired a generalized two-dimensional matching repertoire as a result of the original training. Additionally, two of the children had a history of emotional responding prior to this study and with procedures conducted concurrently outside of the present experiment when prompted responses were not reinforced, yet they displayed almost no emotional responding in the study itself, suggesting that the reinforcement of prompted responses was the reason for the absence of emotional responding.
Keywords: generalized matching, prompting, emotional responding

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Identity matching-to-sample consists of matching a sample stimulus to the corresponding identical comparison stimulus from an array of comparison stimuli (Brown, Brown, & Poulson, 1995). For example, if a learner were presented with an array of stimuli such as a block, car, and spoon (the comparison stimuli), then handed a spoon (the sample stimulus), and told to match, the learner should then place that spoon next to the comparison spoon. After the learner has acquired the ability to match all of the three objects, the experimenter could assess whether he or she had also acquired generalized matching-to-sample by using three different objects, such as a plate, sock, and cup to determine if the learner could match the given sample stimulus with the correct comparison stimulus. If the learner is able to correctly match the novel stimuli, then he or she has acquired a generalized identity matching-to-sample repertoire (Brown, et al., 1995).

Identity matching-to-sample has been demonstrated with various animal species such as pigeons (Cummings & Berryman, 1961; Cummings, Berryman, & Cohen, 1965; Wright, Cook, Rivera, Sands, & Delius, 1988), California sea lions (Pack, Herman, & Roitblat, 1991), bottle nosed dolphins (Herman & Gordon, 1974; Herman, Honvancik, Gory, Bradshaw, 1989), infant chimpanzees (Oden, Thompson, & Premack, 1988), and macaque monkeys (Washburn, Hopkins, & Rumbaugh, 1989; as cited by Brown et al., 1995). Not only did all of the aforementioned experimenters intend to determine whether or not the various species of animals could acquire an identical matching-to-sample repertoire, but also, would a generalized repertoire develop as well. Cumming and Berryman (1961) were unable to get generalized matching with pigeons; however, Cumming, Berryman, and Cohen (1965) got low levels of generalized matching with their pigeons, and Wright, Cook, Rivera, Sands, and Delius (1988) got high levels of generalized matching with their pigeons (as cited by Brown et al., 1995). Dolphins demonstrated generalized matching (Herman & Gordon, 1974; Herman et al., 1989), as did infant chimpanzees (Oden et al., 1988; as cited by Brown et al., 1995). Following identity matching-to-sample training, California sea lions demonstrated some generalization (Pack et al. 1991) and it is unclear if

macaque monkeys acquired a generalized matching repertoire (Washburn et al., 1989; as cited by Brown et al., 1995).

Children under five years of age can acquire identity matching-to-sample, but no attempt seems to have been made to assess generalization (Dixon & Dixon, 1978; Lutzer, 1987; Daehler, Lonardo, & Bukatko, 1979; as cited by Brown, et al., 1995). If a skill is going to be targeted for acquisition, it should be taught not only to mastery, but the generalization of that skill needs to be targeted as well. However, Brown, Brown, and Poulson (1995) demonstrated that three typically developing children were able to acquire generalized identity matching-to-sample.

While many manuals recommend training matching-to-sample to young children with developmental disabilities (Lovaas, 1981; Taylor, & McDonough, 1996), we have not found any literature actually showing that traditional matching-to-sample can be achieved by young children with developmental disabilities. And although, Saunders and Sherman (1986) taught matching-to-sample to three developmentally delayed teenagers; and all three children demonstrated generalized matching repertoire (as cited by Brown et al., 1995) there is still a need to demonstrate not only matching-to-sample, but also generalized matching in young children with developmental delays.

And while generalized matching is an interesting theoretical issue, presumably it is also of considerable practical importance, as the children will have little opportunity to use their matching skills with the specific stimulus used in training. The acquisition of an identity matching repertoire will be of little value to the child if that child has not acquired a generalized matching repertoire, so that he or she can use that skill in a variety of educational and practical contexts where the matching task involves novel, untrained stimuli.

When working with clients with developmental delays the main goal is to help them develop skills in order to acquire a functional repertoire. Matching (matching-to-sample) is a common skill taught to children with developmental delays in early intensive behavioral interventions (EIBI). However, neither journal articles nor curriculum guides for EIBI offer recommendations for how many stimuli are necessary to develop a generalized identity matching-to-sample repertoire or what skill should be targeted following skill acquisition of generalized matching-to-sample (Lovaas, 1981; Taylor, & McDonough, 1996; Dixon & Dixon, 1978; Lutzer, 1987; Daehler, Lonardo, & Bukatko, 1979; as cited by Brown, et al., 1995). Perhaps matching-to-sample is so frequently suggested as an early learner skill due to the other skills that are simultaneously being taught such as scanning of an array and also compliance with an instruction. Furthermore, matching-to-sample is relatively easy to prompt.

Another issue is that many people with developmental delays often fail to respond to environmental cues in the same way as typical learners (MacDuff, Krantz, & McClannahan, 2001). Therefore supplemental stimuli must be used to train skills. These stimuli are referred to as prompts, stimuli designed to increase the likelihood that a correct response will occur (Malott, 2008). Therefore added prompts (response prompts) are often used when training individuals with developmental delays.

Most-to-least (MTL) and least-to-most (LTM) prompting strategies are typical response prompt hierarchies and both have drawbacks. The methodology of this study addresses drawbacks for both MTL and LTM that other studies have not considered. Least-to-most prompting is often criticized for producing errors and that high error rates and low levels of reinforcement can lead to emotional responding (Demchak, 1990; Ducharme, 2003; as cited by Mueller, Palkovic, & Maynard, 2007). In an attempt to reduce the probability of emotional responding, both unprompted and prompted correct responses were reinforced in MTL as well as LTM. However, one negative aspect reported about MTL is that a learner can become prompt dependent if prompts are not faded in a timely and systematic manner. Additionally, since prompts are faded out from most to least prompting, learners are sometimes provided with more assistance than necessary to make a correct response (MacDuff, Krantz, & McClannahan, 2001). In order to address both concerns associated with MTL, each session was started with a probe trial to assess the level of assistance necessary for the learner to make a correct response. This increases the probability that the learner is not receiving more assistance than necessary and provides a systematic way to fade prompts. The present study was originally designed to compare least-to-most prompting, most-to-least prompting, and most-to-least with a delay (MTLD) strategies in an attempt to determine the most effective and efficient prompting strategy for skill acquisition. However, there was no demonstrated difference between the prompting strategies, which may be because all of the children acquired a generalized identical three-dimensional matching repertoire. Thus, the main focus of this report is on the acquisition of a generalized matching repertoire, rather than the type of prompting strategies; see Gaisford (2009) for the original manuscript with an extended comparison of the two prompting strategies.

Methods

Participants

Three students, one female and two males, enrolled in an Early Childhood Developmental Delay (ECDD) classroom at Croyden Avenue School, participated in this study. The ages of the children at the start of the study were two years and seven months, three years and nine months, and four years and eight months. To participate, the children had to have the prerequisite skills for matching objects. All three children received discrete trial instruction three hours a day, five days a week and had been enrolled in the classroom for a range of three to nine months (with an average of six months) at the start of the study.

Setting

The author conducted all the sessions in each child's study carrel, which was approximately 3.0 x 2.0 m. The carrels contained a desk and two chairs, with the experimenter sitting perpendicular to the child.

Interobserver Agreement

Two graduate students collected interobserver data on data sheets identical to the ones used by the experimenter. Interobserver agreement was taken for twenty-five percent of the sessions. The percentage of agreement was calculated by dividing the number of agreements by the number of agreements and disagreements and multiplying by 100. The average percentage of agreement was 97.62 percent with a range of 86.11 percent to 100 percent.

Materials

There were two different sets of training materials; one set of materials for each prompting strategy, LTM and MTL or MTLD. The first set of objects included identical pairs of green plastic plates, pink socks, and yellow wooden blocks; the second set included identical pairs of red plastic cups, blue plastic spoons, and white shoes.

Identification of Reinforcers

Twice a week as part of the regular classroom procedures, children selected eight tangible items from two large bins of tangibles. Following this selection, the eight tangibles along with three to four edibles were arranged on the desk in front of the child. Then a brief multiple-stimulus assessment without replacement (MSWO) was conducted to identify and rank the top five of the eleven to twelve preferred items (Higbee, Carr, and Harrison, 2000). At the beginning of each session the experimenter offered the child the two top-ranked items and used the first one the child selected as a reinforcer for that session. However, if during the session that item lost its' reinforcing value (e.g. the child pushed it away, did not engage with the tangible or did not eat the edible) this process was repeated with the two top-ranked items from the remainder of the array of five.

Procedures

General Procedure

Sessions were run five days a week, with both prompting procedures being used once a day and with at least twenty minutes between sessions. The order of the most-to-least (MTL) and the least-to-most (LTM) procedures were alternated across days. Prior to each session of both conditions, LTM probe trials were conducted.

Probe trials

In order to ensure that the child did not receive more assistance than needed, a probe trial was conducted to determine the appropriate prompt level. At the beginning of each session the experimenter began the probe trial by stating, "Match same," and allowed the child two to three seconds to respond independently. If the child did not respond or made an incorrect response, the experimenter provided the next prompt in the least-to-most prompt hierarchy and again allowed the child two to three seconds to respond. The experimenter continued up the prompt hierarchy until the child made a correct response. The prompt hierarchy was a gestural prompt, partial light physical prompt, partial firm physical prompt, and full physical prompt. The experimenter reinforced all correct responses, both prompted and unprompted. This process was repeated for each of the three stimuli in the array before the session began, for both training strategies, LTM and MTL.

Most-to-Least Prompting

Following the probe trial for each of the three items in the array, the prompt levels that were determined for each stimulus were used for the remainder of the session. In order to avoid extinction, a reinforcer was provided for both prompted and unprompted responses, both in the probe trials and training trials. Even as prompts were faded over successive sessions, a reinforcer was still provided if a prompt level that was higher than the probe session was required for a correct response. This was done to address the possibility that the child could have made a correct independent response due to chance

The instruction, "match same" was repeated for each prompt. The child was given two to three seconds to respond before a higher level prompt was used. If the child made an incorrect response, the object was handed back to him or her while the experimenter simultaneously provided a prompt and repeated the instruction until a correct response was made. If the child did not respond to the instruction, after waiting two to three seconds, the experimenter proceeded to provide a higher level prompt and repeated the instruction until a correct response was made. This procedure was the original design; however, some modifications were made along the way; exceptions to this procedure will be discussed.

Most-to-Least Prompting with a Delay

As will be described later, a delay was introduced in some of the MTL procedures. The Most-to-Least with Delay (MTLD) condition also started with a probe trial for each stimulus and the appropriate prompt level was determined as described before. Following the probe trials, the experimenter held up the stimulus and said, "Match same" and gave the child two to three seconds to respond independently. The two to three seconds to respond independently served as the delay in this procedure. If the child did not respond, or responded incorrectly the experimenter provided the predetermined prompt. All responses were reinforced whether they were independent or prompted (Libby, Weiss, Bancroft, & Aheran, 2008).

Least-to-Most Prompting

A probe trial was conducted for the LTM condition so that each condition would have the same number of trials. The experimenter began the trial by stating the instruction, "match same" and allowed the child two to three seconds to respond independently. The experimenter then proceeded through the least-to-most prompt hierarchy until the child made a correct response. The experimenter repeated the instruction, "match same" with every prompt and allowed the child two to three seconds to respond after each prompt. A reinforcer (the most preferred based on a preference assessment that was conducted immediately prior to the session) was delivered contingent upon the correct response regardless of the prompt level.

Matching-to-Sample Training, Data Collection, and Mastery Criterion

After conducting the probe trial for each of the three stimuli in a given set, the training session began with that set of stimuli using the prompting strategy assigned to that set. Three additional trials for each stimulus in the set were conducted in random order, again for a total of twelve trials per session, including the three probe trials. This same method was repeated for the other set of stimuli using the other prompting strategy, again with a total of twelve trials per session. Data were collected on whether or not any emotional responding occurred during training for both prompting strategies.

To be compatible with the standard classroom criterion, the mastery criterion was two consecutive sessions at 89 percent or better or three consecutive sessions at 75 percent or better; however due to the logistics of the experiment, a few sessions were run past the mastery criteria for all three children. Finally, the number of sessions for acquisition was compared between conditions.

Results

Dawson

Using the most-to-least prompting strategy, Dawson met the mastery criterion by session nine and met the mastery criterion by session ten when using least-to-most prompting (Table 1).

Stephen

By session 24 Stephen had not acquired the matching skill. And the classroom's policy required that if a child had not acquired a skill within 20 sessions, the procedure would be modified; therefore the most-to-least prompting strategy was changed to a most-to-least with delay (MTLD). Using the least-to-most prompting strategy, Stephen met a mastery criterion on session 34 (Table 1). He failed to meet a mastery criterion within twenty sessions using MTL, but once the procedure was switched to MTLD, he met a mastery criterion with only 8 more sessions—32 sessions total, suggesting that the addition of the delay to the MTL condition aided in the acquisition of the matching skill (Table 1).

Kiarra

Because of Stephen's success when the delay was added to the most-to-lest procedure, only MTLD and no simple MTL, was used with Kiarra. However, by the 11th session the experimenter noticed that Kiarra always waited for a second statement of the instruction "Match same," before responding in both the MTLD and LTM conditions. Therefore from the twelfth session on, the experimenter presented the second instruction "Match same," without an accompanying prompt. And for the next two sessions she responded one hundred percent correct to that second instruction with no prompting, suggesting that she had already mastered the matching skill under both MTLD and LTM conditions (Table 1).

Table 1. Number of sessions to mastery

Child	Least-to-Most Prompting	Most-to-Least Prompting/Most-to-Least Prompting with Delay
Dawson	10	9
Stephen	34	32
Kiarra	13	13

After the original matching training, the children's generalized matching repertoires were assessed with different novel objects and two-dimensional stimuli.

Generalized Identical-Object Matching.

When a child met a mastery criterion for object matching, the child was tested for a generalized identical-object matching repertoire. To assess this generalized repertoire, the child was presented with a set of three novel comparison objects, then handed a sample object that matched one of the comparison objects and told, "Match same." This was done three times with each of the three comparison objects, for a total of nine trials. Then the procedure was repeated with three different, novel objects. This testing was done in extinction. All three children performed above the generalization-mastery criterion (80 percent correct) when presented with the six novel identical objects, indicating that all three had acquired a generalized identical-object-matching repertoire (Fig 1.).

Generalized Similar-Object-Matching.

The same testing procedure was used with non-identical, but similar, objects. Both Stephen and Kiarra performed above the generalization-mastery criterion when presented with similar non-identical objects indicating a generalized similar-object-matching repertoire. While Dawson did not meet the generalization-mastery criterion, he still demonstrated better than chance performance, suggesting some generalization (Fig. 1).

Generalized Simple Picture Matching.

The same testing procedure was used with identical, simple, two-dimensional pictures (pictures consisting of a single large shape). The cards were four inches wide by six inches high. For logistic reasons, only Kiarra was tested, and she met mastery criterion (Fig. 1).
Generalized Complex Picture Matching.

Finally, the same testing procedure was used with Kiarra, with identical, complex, two-dimensional pictures (pictures consisting of four or five smaller shapes). The cards were four inches wide by six inches high. Again, Kiarra met mastery criterion (Fig. 1).

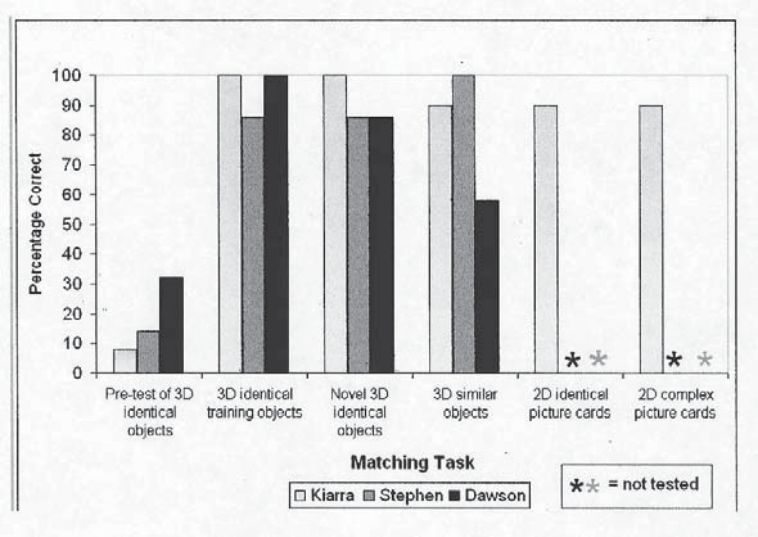

Figure 1. Generalized matching performance

While Stephen and Dawson were not tested for a generalized two-dimensional picture repertoire, Stephen completed the simple and complex matching procedures prior to leaving the classroom and did so with no difficulty during either procedure. Dawson completed the simple and complex matching procedures and three additional two-dimensional matching procedures as part of his curriculum and did so without any difficulty. For all participants, the acquisition of six identical objects led to a generalized identical-matching repertoire and a generalized two-dimensional matching repertoire for one of the participants.

The Reinforcement of Prompted Responses and the Elimination of Emotional Responding

Prompted responses were reinforced in both prompting conditions. This component was done because of the observation of emotional responding by children in the classroom when those children made several errors in a row and thus experienced low rates of reinforcers. Furthermore, one child, Dawson, had a history of emotional responding when the reinforcement density was low, prior to the start of this study. His emotional responding included, crying, whining, swiping instructional materials and slapping his face. After this study, he was in the classroom for one year and nine months and had had over ten procedures that had either been removed from his curriculum or had to be modified because of emotional responding that occurred within those procedures. However, in the present experiment, the reinforcement of prompted responses meant that he always received a high rate of reinforcers; and in this experiment, he emitted almost no emotional responding. In addition, reinforcing prompted responses during other procedures outside of this experiment was also associated with the elimination of emotional responding with those procedures. Stephen also demonstrated emotional responding prior to this study when experiencing low rates of reinforcement. Stephen had near zero levels of emotional responding during this study. Kiarra did not demonstrate high rates of emotional responding prior to this study, and she did not exhibit any emotional responding during the study. This suggests that tutors should reinforce prompted responses if a child has a history of emotional responding during instruction.

Conclusions

This study demonstrated that generalized, identical, three-dimensional matching can reliably result from matching training with as few as six three-dimensional objects; and, at least in some cases, such training can produce generalized matching between similar, non-identical objects and both simple and complex identical pictures. However, there were a few limitations of this study that warrant future research. One such limitation was that only Kiarra was formally tested for a generalized simple and complex identical picture matching repertoire. While both Stephen and Dawson performed well on these tasks when they were a programmed part of their curriculum, we can only speculate as to whether or not they had developed a generalized two-dimensional matching repertoire as a result of the original identical object matching training. It is also possible that all three students could have developed an even more extensive matching repertoire than was tested such as three-dimensional to two-dimensional matching. The design of the original experiment included a total of six identical objects for training matching to sample; however, it is not known if the training of six objects is needed to obtain the level of generalized matching that was achieved by the three children in this study or if similar results can be achieved by training with fewer objects. Future research should systematically determine

how many objects are needed to acquire a generalized matching repertoire and if the training of just identical object matching leads to a generalized two-dimensional matching repertoire. Such information could assist practitioners in selecting curriculum and should also prompt assessments to determine if students have acquired a generalized matching repertoire. Furthermore, this study strongly suggested that reinforcing prompted responses can essentially eliminate emotional responding for children who tend to respond emotionally when prompted responses are not reinforced; however, replication is needed to determine if the results found in this experiment can be generalized to other young learners with developmental delays.

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Author's Note

This study is based on a thesis conducted by Kristen Gaisford in partial fulfillment of the requirements for the PhD degree in Behavior Analysis at Western Michigan University. She is now at Evidence-Based Behavioral Consultation in Elko, Nevada.

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