Differential Outcomes Effect in Children and Adults With Down Syndrome

Angeles F. Estévez and Luis J. Fuentes
Universidad de Almería (Almería, Spain)

J. Bruce Overmier
University of Minnesota, Twin Cities

Carmen González
Universidad de Murcia (Murcia, Spain)

Abstract
In previous studies, researchers have demonstrated that learning of symbolic relations is facilitated when a particular outcome is associated with each relation to be learned. In the present study, we extend this differential outcomes procedure to children and adults with Down syndrome who had to learn a symbolic conditional discrimination task. Participants showed a better terminal accuracy and a faster learning of the task when the alternative correct responses were each followed by unique different outcomes than when nondifferential outcomes were arranged. These findings confirm that the differential outcomes procedure can be a useful tool to ameliorate discriminative learning deficits and demonstrate the benefits of this procedure for people with Down syndrome.

Those working with learning and memory challenged populations are always seeking new ways to help their clients. Sometimes, apparently small procedural changes can make important differences in clients' success in learning. In the present study we demonstrate one such case.

When in a conditional discrimination task (such as matching-to-sample), each of the different correct stimulus–response sequences is rewarded with its own unique reinforcer, the learning is faster and the performance is better than when all correct responses are followed by a common outcome, which is the traditional, standard training procedure. This enhancement in both acquisition and performance of the task is called the *differential outcomes effect* (Peterson & Trapold, 1980). This effect has been demonstrated in both animal and human populations, although most of the results come from studies with pigeons and rats (for a review, see Goeters, Blakely, & Poling, 1992). Maki, Overmier, Delos, and Gutman (1995) and Estévez, Fuentes, Mari-Beffa, González, and Alvarez (2001) demonstrated that children without mental retardation, ranging in age from 4.6 to 8.6 years, learned faster and performed better on a symbolic matching-to-sample task when taught with the differential outcomes procedure.

To date, only a very few researchers have focused on the possibility of using the differential outcomes procedure in human beings as a teaching aid. With one exception (Dube, Rocco, & McIlvane, 1989), in each of these studies there was evidence that people exposed to differential outcomes learned the discrimination task faster or exhibited greater terminal accuracy than those who received nondifferential outcomes. The differential outcomes effect has been found in four studies in which researchers examined acquisition of a two-choice successive conditional discrimination by children and adults with mental retardation and by children with autism (Litt & Schreibman, 1981; Malanga & Poling, 1992; Saunders &

Sailor, 1979; Shepp, 1962). In two recent studies from our laboratories, investigators examined the effectiveness of this procedure to ameliorate deficits presented by different clinical patients. Joseph, Overmier, and Thompson (1997) demonstrated that adults with Prader-Willi syndrome learned concepts and complicated equivalence relations significantly better when differential outcomes were used (see also Dube, McIlvane, Mackay, & Stoddard, 1987). In an interesting extension of differential outcomes effect research on memory with animals (Savage, Stanchfield, & Overmier, 1994), Hochhalter, Sweeney, Bakke, Holub, and Overmier (2000) found that people with alcohol-induced amnesia showed significantly better face recognition at delays when differential outcomes were arranged and, thereby, established the potential for this procedure as an aid to memory in older adults with memory impairment. Although in these studies overall accuracy was much greater under the differential outcomes condition, the accuracy of some individual participants varied considerably across conditions and was not always higher when differential outcomes were arranged (see Hochhalter et al., 2000; Litt & Schreibman, 1981). Interestingly, in these individual cases, the participants exhibited high levels of accuracy under nondifferential outcomes condition, indicating perhaps the presence of a ceiling effect. It is possible that the task used was too easy for these participants. As Estévez et al. (2001) indicated, when a task is simple and participants can easily solve it, there is no benefit of using the differential outcomes procedure.

The results obtained in these aforementioned studies strongly suggest that it is reasonable to consider the use of the differential outcomes procedure as a technique for facilitating the learning and memory of conditional symbolic relationships. However, given the scarce number of studies about the differential outcomes effect in human beings, further investigations are needed to isolate the conditions and populations for whom the differential outcomes effect does or does not occur. In the present study, we sought to determine whether the differential outcomes procedure could be a useful tool to improve the discriminative learning of symbolic relations by children and adults with Down syndrome who usually find this challenging.

Down syndrome is a chromosomal disorder caused by the presence of an extra chromosome 21 in some or all the cells of the individual. People with Down syndrome often share physical features that can be easily recognized from birth (e.g., flat facial profile, a short neck, brushfield spots), as well as a group of medical disorders (e.g. congenital heart disease, hearing loss, vision disorders). Along with these problems, they may present a range of cognitive deficits and most of them have IQs that fall in the mild to moderate range of mental retardation. Their cognitive deficits usually include (a) difficulties forming concepts and processing symbolic and abstract materials, and, therefore, learning symbolic discriminations (Belmont, 1971; Cornwell, 1974; Gibson, 1978; Silverstein, Legutki, Friedman, & Takayama, 1982); (b) short-term memory deficit (Jarrold, Baddeley, & Hewes, 2000; Marcell & Armstrong, 1982; McDade & Adler, 1980); and (c) delayed vocabulary development that may occur because people with Down syndrome have difficulties learning the relationships among the objects, people, or events and the words that symbolize them (Arraiz, 1994). Furthermore, researchers have found that during learning, rate of acquisition of these individuals is usually slow, whereas their capacity to learn is quite good (Molina & Arraiz, 1993). Such potential suggests that the use of methods adapted to the capacities of individuals with Down syndrome could positively influence their overall functioning and solve, or at least ameliorate, some of their problems (e.g., their difficulties in processing symbolic conditional relations).

In the present study we specifically addressed the conditional discriminative learning and short-term memory deficit characteristic of people with Down syndrome related to concepts and symbolic relations. Because the use of the differential outcomes procedure has lead to better accuracy and faster symbolic discriminative learning in other clinical populations than has the traditional nondifferential outcomes procedure, we thought that it might well prove to be an effective teaching method for people with Down syndrome. Therefore, we tested whether Down syndrome clients would improve their learning and memory of discriminative symbolic relations in a delayed symbolic matching-to-sample task when differential outcomes were arranged. We used the delayed symbolic matching task because (a) short delays between objects and labels are common in real life and (b) such delays increase the difficulty of learning the relation due to the burden the delay puts on short-term memory.

Method

Participants

Participants were 24 children and adults with Down syndrome. They were recruited from the 'Asociación Almeriense para el Síndrome de Down' (ASALSIDO) in Almería, Spain. The participants ranged in age from 6 to 37 years.

Materials and Stimuli

Each participant sat to the right of the experimenter in a quiet room. Between them was a book containing the stimuli, which were drawings measuring approximately 5 × 5 cm and belonging to the groups of symbols included in Microsoft Word95. Each trial consisted of four pages. The first page contained the number of the trial written in the lower right corner. The second page had the discriminative cue stimulus, a so-called "sample stimulus," centered on the top half of the page. The third page was blank and served as an approximate 2-second delay. Finally, the fourth page contained two comparisons or choice stimuli on the bottom half of the page. Choices were centered equidistant from one another.

Participants received primary and secondary outcomes following their correct choice responses. A red and a green bowl containing red and green tokens, respectively, were to the left of the experimenter. Two other bowls, one red and one green, were at the participant's right. Following a correct choice response, they received either a red or a green token, which they then placed in their corresponding red or green bowl. Once the session was completed, participants exchanged the red tokens for foods and the green tokens for toys. Food reinforcers consisting of cookies, candies, and triskis and gublins balls (two kinds of cereals) were located in the red bin. Small toy reinforcers (e.g., crayons, stickers, masks, and globes) were located in the green bin. For participants older than 10 years, the toys bin contained pens of several colors, note pads, decorated envelopes and paper, pencils, and erasers. The bins were located behind the participants and out of their immediate sight. The experimenter controlled stimulus presentations, data collection, and outcome presentations. For reliability checks of the experimenter's scoring and reinforcement procedures, an observer continuously present in the experimental setting independently recorded the participant's responses and the reinforcement procedure being used for all trials.

Procedure

The experiment consisted of several phases. First, the experimenter (first author) assessed participants to determine their mental age (MA) using different scales: the McCarthy Scales of Children's Abilities, Wechsler Intelligence Scale for Children-Revised (WISC-R), or Wechsler Adult Intelligence Scale-Revised (WAIS-R). The Peabody Picture Vocabulary Test (PPVT) was also administered to each of them because this is a frequently used measure to assess people with mental retardation and correlates highly with the intelligence scales previously mentioned. The scores of each participant, along with their demographic characteristics, are summarized in Table 1.

Two experimental sessions, one a week, followed the psychological assessment phase. In each session, participants performed a delayed conditional discrimination task. The task was the same, but the stimuli used (Stimuli Sets 1 and 2) and, therefore, the associations between the sample stimuli and the choice comparison stimuli to be learned were different. In the first session, participants were assigned randomly to one of two experimental treatments, such that half of them served in the differential outcomes condition and the other half, in the nondifferential outcomes, or control, condition. The opposite was true during the second session. This procedure allowed us to assess for each participant whether the use of the differential outcomes facilitated learning and performance on the discriminative task when compared to traditional or nondifferential reinforcement. Participants in the differential outcomes condition received a green token following the correct choice of one of the comparison stimuli and a red token following the correct choice of the other. Those participants in the nondifferential condition received random rewards of either red or green tokens for correct choices. Although the nondifferential reinforcement control condition may be carried out in several different ways (e.g., using the same single common reinforcer for every correct trial or random mixing of the two reinforcers from the differential outcomes procedure), past research has established that these control procedures yield the same outcome (Carlson & Wielkiewicz, 1976; Litt & Schreibman, 1981; Saunders & Sailor, 1979). We chose to use the mixed procedure because it better equates the to-

Table 1. Participants' Characteristics

Name	Gender	CA	Tests scores[a]			PPVT[b]
			Test	MA	IQ	
Re.	M	6–1	MSCA	<3.1		3–5
B.	M	6–5	MSCA	<3.3		3–8
L.	M	6–9	MSCA	<3.6		3–10
R.	M	7–6	MSCA	<3.11		3–7
J. A.	F	8–0	WISC	<6	<40	5–2
I.	M	9–3	WISC	<6	<40	5–2
Be.	M	10–0	WISC	<6	<40	5–1
M. A.	F	10–6	WISC	<6	<40	4–10
M.	F	11–1	WISC	<6	<40	5–8
C.	F	11–6	WISC	<6	<40	3–6
J. F.	F	12–5	WISC	<6	<40	3–5
Ir.	M	13–3	WISC	7.2	42	9–5
La.	M	13–3	WISC	8	45	9–1
P.	F	13–6	WISC	<6	<40	4–1
Cr.	M	13–9	WISC	7.2	<40	7–3
M. M.	M	15–3	WISC	<6	<40	5–2
F.	F	15–5	WISC	<6	<40	5–7
A.	F	17–7	WAIS		61	7–1
S.	M	19–3	WAIS		59	7–4
M. An.	F	20–1	WAIS		63	7–8
J.	F	20–4	WAIS		70	9–10
J. M.	F	21–2	WAIS		59	7–1
I. M.	M	29–4	WAIS		55	5–3
R.	F	37–2	WAIS		55	5–11

[a]MSCA = McCarthy Scale of Children's Ability, WISC = Wechsler Intelligence Scale for Children, WAIS = Wechsler Adult Intelligence Scale. [b]Age equivalent scores for the Peabody Picture Vocabulary Test in years–months.

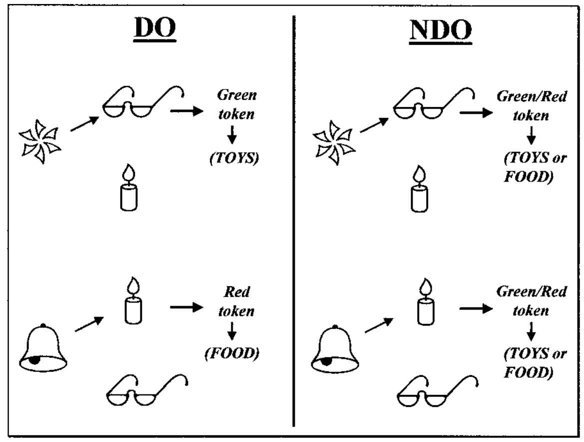

Figure 1. An example of the condition used in the present study. DO = differential outcomes condition, (NDO) = nondifferential outcomes condition.

tal experiences of the experimental and control treatments. Figure 1 shows an example of our selected procedures. Incorrect choices led to an approximate 3-second intertrial interval, and, then, the next trial in a noncorrection procedure took place.

The task consisted of three different phases: pretest and Conditional Discrimination Phases 1 and 2. Figure 2 shows the stimuli used in each phase, which were held in separate binders. The pretest phase consisted of 4 identity matching trials and 8 conditional discrimination trials. This phase ensured the participant's ability to discriminate the stimuli to be used and familiarize them with the delayed matching-to-sample task. On the first identity trial, the experimenter explained that they were going to play a memory game, and when they responded correctly they would win a token that they could exchange later for a prize. Then, the experimenter showed the participant the association between red tokens and food and green tokens and toys. Participants were instructed to point to the sample stimulus and then, when given the opportunity to choose, the comparison stimulus that went with the sample.

On the first conditional discrimination trial, the participants received additional instructions. They were informed that the game would change a little. The picture on the top of the page (the sample stimulus) would not look like either of the two pictures on the bottom of the page (the comparison stimuli). They had to guess which picture

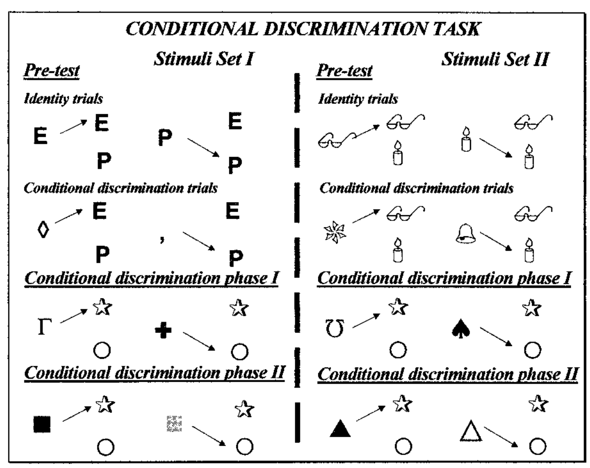

Figure 2. Stimuli used in each phase of the experiment.

was associated with the sample stimulus and then remember which picture went with each sample stimulus. It is important to note that the instructions at the beginning of the second session varied a little because children were informed that they would continue playing the same game that they had played the previous week. Then the experimenter gave the same instruction that was used in the first session.

Delays were introduced gradually in the following manner. The first and second identity pretest trials and the first and second conditional discrimination pretest trials included no delay. For these four trials, the sample stimulus and the two comparison pictures appeared on the same page. The third and fourth identity pretrest trials and the third through fifth conditional discrimination pretest trials incorporated a delay of approximately one second. For these trials, the sample stimulus was on one page and the two comparison stimuli were on the next page. The last three pretest conditional discrimination trials incorporated a delay of approximately 2 seconds. For these trials, a blank page inserted between the sample stimulus and the comparison stimuli served as the delay.

Thirty-two Conditional Discrimination Phase 1 trials, randomized in blocks of 8 trials, followed the pretest phase. Each sample stimulus appeared 4 times per block, and correct choice stimuli appeared on each side of the page an equal number of times.

In Conditional Discrimination Phase 2, there were 32 trials with the stimuli set also randomized in the manner described above. The choice stimuli were the same as those used in the Conditional Discrimination Phase I, but the sample stimuli were different, thus requiring the learning of new symbolic relations.

Results

The percentage of correct responses, based on data gathered by the experimenter (the first author), was determined for each session. An independent observer also recorded data throughout the experiment. The reliability assessments revealed no disagreements between experimenter and observer on either response or reinforcement condition. The experimenter was trained to avoid giving any cues for correct choice. Observations of the procedure for reliability purposes included face-to-face views of the experimenter on some occasions to check for cueing. These observations revealed no occurrences of such cues as hand or eye movements in the direction of the correct comparison stimulus.

Subject-by-Subject Analysis

Data for each participant in the Conditional Discrimination Phases 1 and 2 and both collapsed were analyzed using the chi-square test. A significant chi-square, $p < .05$, for an individual indicated that the differential outcomes effect was obtained; this was evident for 19 participants in Phase 1, 20 participants in Phase 2, and all of them ($N = 24$) when both phases were collapsed. That is, the participants in the study typically performed the task better when they obtained differential outcomes after their correct responses than when they received nondifferential outcomes. Data from both phases collapsed indicated that some of the participants might have needed more training in either Phase 1 or Phase 2 in order to observe a significant beneficial effect of differential outcomes. A survey of the characteristics of those who failed to benefit from the differential outcomes procedure versus those who did benefit failed to reveal any specific identifying characteristic (e.g., chronological age, IQ).

Analysis as a Function of MA

Based on participants' MAs, calculated using the scales previously mentioned (mainly the PPVT), participants were categorized into three groups: from 3 to 4.92 years (Group 1); from 5 years to 6.92 years (Group 2); and from 7 to 9.92 years (Group 3). We used MA and not IQ as a criterion to form the groups because researchers have demonstrated that for people with Down syndrome, IQ drops as age increases (mainly at adolescence and over 35 to 40 years), which would imply a deterioration in mental capacity. However, because MA continues to increase, suggesting intellectual capacity is increasing too, classification on IQ would not be accurate (Anastasi, Lamber, & Rondall, 1989; Del Barrio, 1991). Thus, although we obtained both measures, we decided that MA would be the most appropriate way to group the participants with similar cognitive abilities.

To assess whether participants exhibited greater accuracy when they received differential outcomes following their correct responses than when they received nondifferential outcomes, data from Conditional Discrimination Phases 1 and 2 were analyzed. Correct choices were analyzed through a mixed ANOVA, with outcome (differential vs. nondifferential) as the within-subjects factor and MA (3.0 to 4.92, 5.0 to 6.92, and 7.0 to 9.92) as the between-subjects factor. Because the pattern of results was similar for males and females, data were collapsed across gender for the statistical analyses. Figure 3 shows the mean percentage of correct choices in both phases as a function of outcomes and MA.

Results showed a significant main effect of outcomes in both phases: Conditional Discrimination 1, $F(1, 21) = 211.78$, $p < .001$, and Conditional Discrimination 2, $F(1, 21) = 183.64$, $p < .001$. Consistent with the results obtained when data from each participant were analyzed separately, groups learned the conditional discrimination task best when differential outcomes were arranged. In fact, under the nondifferential outcomes condition, participants showed performance close to chance (54% in both conditional discrimination phases).

There was also a significant main effect of MA in the Conditional Discrimination Phase 1, $F(2, 21) = 9.06$, $p < .01$. The overall performance of participants was least accurate for the youngest age group and increased gradually with MA (66%, 69%, and 73% accuracy for each MA group, respectively). These data indicate that the task was very difficult, but the difficulty decreased as a function of MA.

Some researchers have suggested that switching the scheduled rewards from differential to nondifferential disrupts the choice behavior, even though every correct response continues to produce a reward (Honig, Matheson, & Dodd, 1984; Peterson & Trapold, 1980). Because the participants who received nondifferential outcomes in the second session had received differential outcomes condition in the first session one week earlier, it is possible that their discriminative performance in this second condition was worse than that obtained by those who received nondifferential outcomes in the first session. To assess this possibility, we contrasted data from participants who received nondifferential outcomes in the first session with those who received nondifferential outcomes in the second session through a one-way ANOVA, with session as the between-subjects factor. There were no significant differences between participants who received nondifferential outcomes, despite the fact that half of them received them in the first session and the others, in the second one.

Acquisition

To determine whether participants learned the discrimination task faster when they received differential outcomes for correct choices, we analyzed the course of their learning within the different phases, Conditional Discrimination Phases 1 and 2, grouping the trials in 8 blocks of 4 trials each. Figure 4 shows the percentage of correct responses across blocks of trials in both phases as a function of outcomes treatment. Data from the Conditional Discrimination Phase 1 were analyzed through a mixed ANOVA, with MA as the between-subjects factor and outcomes and block of trials (1, 2, 3, 4, 5, 6, 7, and 8) as the within-subjects factors. The results showed significant main effects of MA, $F(2, 21) = 5.58$, $p < .05$, outcomes, $F(1, 21) = 99.80$, $p < .001$, and block

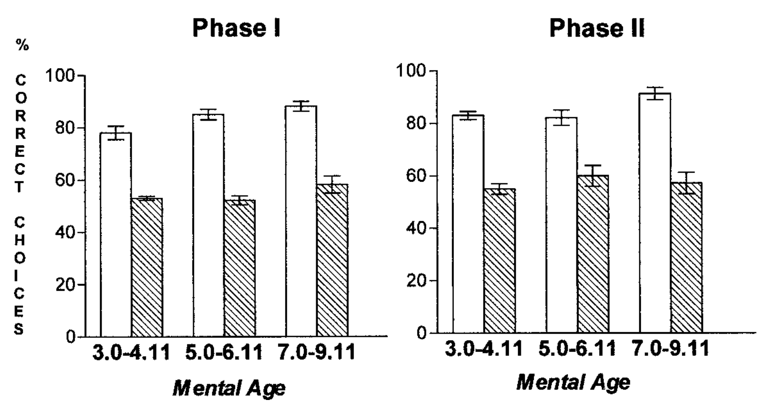

Figure 3. Mean percentages of correct choice responses as a function of outcomes (D [blank bars] = differential, and ND [hatched bars] = nondifferential) and MA for Conditional Discrimination Phases 1 and 2. The error bars show the standard error.

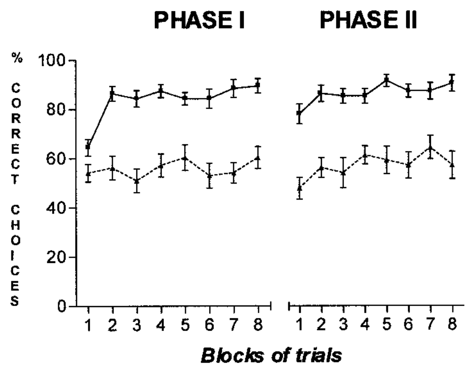

Figure 4. Mean percentages of correct choice responses as a function of blocks of trials (8 blocks of 4 trials each) and outcomes (D = differential [straight lines] and ND [dotted lines] = nondifferential) for Conditional Discrimination Phases 1 and 2. The error bars show the standard error.

of trials, $F(7, 147) = 3.50$, $p < .01$. The overall performance of participants was less accurate for the youngest MA group, and, in general, participants learned the task better when differential outcomes were arranged.

Most important, the Outcomes × Block of Trials interaction was also significant, $F(7, 147) = 2.16$, $p < .05$. Analysis of the interaction revealed a significant main effect of block of trials when the participants received differential outcomes, $F(7, 161) = 6.90$, $p < .001$, but not when they received nondifferential outcomes. Data from this phase indicated that participants only learned the conditional discrimination task when they received differential outcomes following their correct responses. Performance in the first block of trials was similar in both conditions.

Data from the Conditional Discrimination Phase 2 were similarly analyzed. The results showed only significant main effects of outcomes, $F(1, 21) = 183.69$, $p < .001$, and blocks of trials, $F(7, 147) = 2.14$, $p < .05$. That is, in general, performance was better in the differential outcomes condition and increased with blocks of trials. Analysis of the data from the first block of trials revealed that participants showed better performance when they received differential outcomes following their correct responses than when they received nondifferential outcomes, $F(1, 23) = 25.22$, $p < .001$.

Discussion

Our main goal was to determine whether the differential outcomes procedure would have a facilitative effect on the learning and memory of symbolic relations in a conditional discrimination task by people with Down syndrome. The results obtained fully support this hypothesis. That is, the use of differential outcomes enhanced learning rate and asymptote when data from participants were analyzed either subject-by-subject or grouped as a function of their MA. Both children and adults with Down syndrome who participated in this study showed better overall accuracy and learned a conditional discrimination task faster under the differential outcomes condition. In fact, the task appeared almost unlearnable when the participants received nondifferential outcomes following their correct responses, but readily learnable when differential outcomes were arranged. Thus, the differential outcomes procedure enables clients with Down syndrome to learn symbolic conditional discriminative relations that in other circumstances would be very difficult for them to learn.

Clearly, the operation of linking specific samples, choices, and reinforcements is a critical feature. Why is this operation effective? The theoretical explanation of why arranging differential outcomes is an aid to learning that has received substantial support is the expectancy theory, originally proposed by Trapold and Overmier (1972). They asserted that under a differential outcomes condition, as a result of the unique associations between the sample stimuli and the outcomes, each sample comes to elicit an expectancy of the association-unique reinforcer. The elicited expectancies are hypothesized to have distinctive cue properties, which, in turn, guide choice behavior. Thus, this theory places emphasis on the differential association between the sample stimulus and the unique outcomes as the source of the expectancies. In the present study, one result of theoretical importance is that—as in a previous study with children without mental retardation (Estévez et al., 2001)—when children and adults with Down syndrome received differential outcomes following their correct responses in Phase 1, they also showed better performance in the first block of trials of the Conditional Discrimination Phase 2. This might have occurred because the same correct choice alternatives and reinforcers were used in the two successive phases of the task (Discrimination Phases 1 and 2), with only the discriminative sample stimuli changing. The association between the expectancy of the outcome and the choice alternatives was maintained between Conditional Discrimination Phases 1 and 2, and it might have contributed to the faster learning seen in the first trials of Phase 2 under differential outcomes condition. Alternatively, the choice alternative–outcome association per se could have contributed to the enhanced learning observed under a differential outcomes procedure in Phase 2 and, possibly, even to the differential outcomes effect itself. This latter possibility is currently a matter for further research. Although the present experiment does not directly assess the theoretical mechanisms, this consideration of them may help researchers and clinicians conceive of more diverse applications of the differential outcomes effect techniques so as to assist clients in new ways.

The differential outcomes effect has not been intensively studied in human beings, and until now it has not been demonstrated in people with Down syndrome. It is worth noting that children and adults with Down syndrome have discriminative learning deficits mainly with respect to symbolic and abstract materials, such as those used in this experiment. However, this type of conditional discriminative choice learning is common and important to our success in our daily life as well. For instance, when following a cookbook recipe, we may have to discriminate between the letters *t* and *T* that mean teaspoon and tablespoon, respectively. That is, we need to correctly associate the letters *t* and *T* with their respective spoon size; failure to do so means failure to adequately prepare a meal. People with Down syndrome have deficits in conditional discriminative learning and, therefore, recipes including this type of discrimination may be a special challenge for them. Our daily life offers many similar examples (e.g., choices of clothing conditional on the weather prediction symbols in the newspaper); therefore, it is useful and necessary to employ techniques to ameliorate learning deficits of people with Down syndrome and to facilitate their discriminative performance in such everyday tasks. The present results suggest that the differential outcomes method used in this study can be such a technique and is one that is easy to implement in a teaching environment. Further investigation is needed to test the usefulness of the differential outcomes procedure with other populations and in applied contexts.

References

Anastasi, A., Lamber, L. P., & Rondall, C. (1989). *El mongolismo.* Barcelona: Herder.

Arraiz, A. (1994). Deficiencia mental: Niños con síndrome de Down. In S. Molina García (Ed.), *Bases psicopedagógicas de la educación especial* (pp. 384–406). Alcoy, Spain: Marfil.

Belmont, J. M. (1971). Medical-behavioral research in retardation. In N. R. Ellis (Ed.), *International review of research in mental retardation* (pp. 181–196). New York: Academic Press.

Carlson, J. G., & Wielkiewicz, R. M. (1976). Mediators of the effects of magnitude of reinforcement. *Learning and Motivation, 7,* 184–196.

Cornwell, A. C. (1974). Development of language, abstraction and numerical concept formation in Down syndrome children. *American Journal of Mental Deficiency, 79,* 179–790.

Del Barrio, J. A. (1991). Evaluación del desarrollo psicolingüístico en los niños con síndrome de Down en edad escolar. In J. Florez & V. Troncoso (Eds.), *Síndrome de Down* (pp. 111–150). Barcelona: Salvat.

Dube, W. V., McIlvane, W. J., Mackay, H. A., & Stoddard, L. T. (1987). Stimulus class membership established via stimulus-reinforcer relations. *Journal of the Experimental Analysis of Behavior, 47,* 159–175.

Dube, W. V., Rocco, F. J., & McIlvane, W. J. (1989). Delayed matching-to-sample with outcome specific contingencies in mentally retarded humans. *Psychological Record, 39,* 483–492.

Estévez, A. F., Fuentes, L. J., Mari-Beffa, P., González, C., & Alvarez, D. (2001). The differential outcomes effect as a useful tool to improve conditional discrimination learning in children. *Learning and Motivation, 1*(32), 48–64.

Gibson, D. (1978). *Down syndrome: The psychology of mongolism.* Cambridge: Cambridge University Press.

Goeters, S., Blakely, F., & Poling, A. (1992). The differential outcomes effect. *Psychological Record, 42,* 389–411.

Hochhalter, A. K., Sweeney, W. A., Bakke, B. L., Holub, R. J., & Overmier, J. B. (2000). Improving face recognition in alcohol dementia. *Clinical Gerontologist, 22*(2), 3–18.

Honig, W. K., Matheson, W. R., & Dodd, P. W. D. (1984). Outcome expectancies as mediators for discriminative responding. *Canadian Journal of Psychology, 38,* 196–217.

Jarrold, C., Baddeley, A. D., & Hewes, A. K.

(2000). Verbal short-term memory deficits in Down's syndrome: A consequence of problems in rehearsal? *Journal of Child Psychology and Psychiatry and Allied Disciplines, 41,* 223–244.

Joseph, B., Overmier, J. B., & Thompson, T. (1997). Food and nonfood related differential outcomes in equivalence learning by adults with Prader-Willi syndrome. *American Journal on Mental Retardation, 101,* 374–386.

Litt, M. D., & Schreibman, L. (1981). Stimulus-specific reinforcement in the acquisition of receptive labels by autistic children. *Analysis and Intervention in Developmental Disabilities, 1,* 171–186.

Maki, P., Overmier, J. B., Delos, S., & Gutmann, A. J. (1995). Expectancies as factors influencing conditional discrimination performance of children. *Psychological Record, 45,* 45–71.

Malanga, P., & Poling, A. (1992). Letter recognition by adults with mental retardation: Improving performance through differential outcomes. *Developmental Disabilities Bulletin, 20,* 39–48.

Marcell, M. M., & Armstrong, V. (1982). Auditory and visual sequential memory of Down syndrome and nonretarded children. *American Journal of Mental Deficiency, 87,* 86–95.

McDade, H., & Adler, S. (1980). Down syndrome and short-term memory impairment. Storage or retrieval deficit? *American Journal of Mental Deficiency, 84,* 561–567.

Molina, S., & Arraiz, A. (1993). *Procesos y estrategias cognitivas en niños deficientes mentales.* Madrid: Pirámide.

Peterson, G., & Trapold, M. A. (1980). Effects of altering outcome expectancies on pigeons' delayed conditional discrimination performance. *Learning and Motivation, 11,* 267–288.

Saunders, R., & Sailor, W. (1979). A comparison of three strategies of reinforcement on two-choice learning problems with severely retarded children. *AAESPH Review, 4,* 323–333.

Savage, L. M., Stanchfield, M. A., & Overmier, J. B. (1994). The effects of scopolamine, diazepam, and lorazepam on working memory in pigeons: An analysis of reinforcement procedures and sample problem type. *Pharmacology Biochemistry and Behavior, 48,* 183–191.

Shepp, B. E. (1962). Some cue properties of anticipated rewards in discrimination learning of retardates. *Journal of Comparative and Physiological Psychology, 55,* 856–859.

Silverstein, A. B., Legutki, G., Friedman, S., & Takayama, D. (1982). Performance of Down syndrome individuals on the Stanford-Binet Intelligence Scale. *American Journal of Mental Deficiency, 86,* 548–551.

Trapold, M. A., & Overmier, J. B. (1972). The second learning process in instrumental learning. In A. H. Black & W. F. Prokasy (Eds.), *Classical conditioning II: Current research and theory* (pp. 427–452). New York: Appleton-Century-Crofts.

Received 10/16/01, accepted 5/7/02.
Editor-in-charge: William E. MacLean, Jr.

This research was supported by Grant PM97–0002 from D.G.E.S., Ministerio de Educación y Cultura. We thank staff from the Asociación Almeriense para el Síndrome de Down for their contributions and help in recruiting participants for the experiment. We also thank three anonymous reviewers for their helpful comments. Requests for reprints should be sent to Angeles F. Estévez, Departamento de Neurociencia y Ciencias de la Salud, Universidad de Almería, 04120 Almería, Spain. E-mail: mafernan@ual.es.

