The stability and transferability of errorless learning in children with Down's syndrome

Louise A Duffy

Clinical Psychologist

Jennifer G Wishart

Senior Research Fellow

Edinburgh Centre for Research in Child Development
Department of Psychology
University of Edinburgh

An errorless learning procedure was used to teach discrimination to two groups of children with learning disabilities, one composed of children with Down's syndrome, the other of children without Down's syndrome. Both groups responded positively to errorless teaching, with the children with Down's syndrome requiring fewer training trials and showing better retention of the target discrimination than the children without Down's syndrome. The errorless technique proved to have little value in teaching children with Down's syndrome discrimination skills *per se*, however, since they showed little evidence of any transfer of learning to a second discrimination task. Errorless teaching strategies may nevertheless have an important role to play in increasing motivation to learn in children with Down's syndrome, being most effective when used in conjunction with conventional trial-and-error methods.

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Introduction

In an earlier paper by the present authors (Duffy and Wishart, 1987), the efficacy of two differing strategies for teaching discrimination to children with Down's syndrome were compared: errorless and trial-and-error learning. Children with Down's syndrome aged 6-10 years were found to respond positively to an errorless approach, attaining comparatively better scores, both in training and in post-tests, than when presented with a similar task taught by trial and error. Through analysis of the effects of order of presentation of the two teaching strategies, it was demonstrated that exposure to errorless learning could lead to enhanced performance on trial-and-error tasks.

Children with Down's syndrome presented with the errorless task first produced consistently better scores on both the errorless task and on a subsequent trial-and-error task than children experiencing the two tasks in reverse order. There was little evidence of such an effect being present in the scores of a control group of non-developmentally delayed children, indicating a difference in the extent to which experience of success and failure during training had affected the learning process in the two groups.

The experiments to be presented here extend the 1987 study in a number of ways. Firstly, they investigate whether an errorless approach has any real learning value by testing a) the longevity of any gains made, and b) whether what has been learned transfers successfully to another task requiring similar discrimination skills. Secondly, the experiments examine response to errorless training a) in children with Down's syndrome of a wider age range, 6-16 years, and b) in similarily- aged children with learning difficulties of different aetiology, the latter with a view to determining whether motivational factors influence performance to the same extent in children with and without Down's syndrome. Were performance factors found to be similar in both groups of children, this would suggest that in some cases at least, findings from developmental studies of children with Down's syndrome might also be applicable to other sections of the learning-disabled population.

Athough only a small number of empirical studies of errorless learning have been carried out to date, all have consistently demonstrated the effectiveness of errorless training in teaching skills to children and adults previously unresponsive to trial and error teaching (Cullen 1976; McIvor and McGinley 1983; Adams 1984). The Duffy and Wishart (1987) study demonstrated that while children with Down's syndrome had the cognitive capacity to learn from conventional trial and error experience, they were more likely to demonstrate this capacity after initial 'priming' with an errorless approach.

The current class-room popularity of the technique appears to further endorse the practical advantages of an errorless approach over more conventional teaching methods. On a more theoretical level, its adoption implies a recognition of the important role that motivational deficits may play in undermining the progress of development in learning disabled children. Whereas previously, their failure to learn has typically been attributed solely to cognitive deficits, the growing use of success-only techniques seems to reflect an appreciation that the process of learning itself may be being inhibited by the adverse balance of success to failure inevitably experienced by any child with a learning disability.

Increasing attention to errorless teaching strategies also reflects a growing recognition that the development of cognitive ability in children with learning disabilities cannot be studied in isolation. The focus of psychological research into Down's syndrome in particular is increasingly turning to the study of the relationships between cognitive abilities and development in other areas, such as affect, attachment and play (Ciccheti and Sroufe 1976; Cicchetti and Serafica 1981; Thompson et al 1985; Beeghly et al 1989; Cicchetti and Beeghly 1990). Surprisingly perhaps, the relationship between competence and performance - perhaps the most readily observable measure of motivation - has not thus far been addressed in this 'expanded' developmental perspective on Down's syndrome. Despite widespread recognition of the interplay between cognitive and motivational factors in the development of normally-developing children, the potential significance of this relationship is generally overlooked in discussions of the learning difficulties of developmentally delayed children. It is not that cognitive and motivational factors are not recognised as relevant contributory factors but typically their roles are discussed independently of each other in this context. It seems highly probably, however, that the motivational problems which must result from frequent, early experience of failure *contribute directly* to the growth of learning difficulties in such children, exacerbating their pre-existing deficits in cognitive ability and slowing developmental rate even further.

Recent research with children with Down's syndrome has suggested that motivational deficits can indeed impede performance, at least in formal testing situations. In a study of the test/re-test reliability of performance on two widely-used tests of infant cognitive development, a significant gap between performance and competence was found to be characteristic in children with Down's syndrome (Wishart and Duffy, 1990). In many cases, failure to reproduce successes on items passed in an earlier session were often due to a refusal to engage in the task on the second occasion rather than to any obvious loss of the required skill in the interim two weeks. Longitudinal data from Duffy (1990) indicate that this reluctance to perform to optimal capacity on specific test items may be related to an extended experience of failing during the early stages of acquiring the particular skills required for that item - that is, that children come to avoid situations in which they expect to experience failure (see also Cromwell, 1967).

Wishart and Duffy's 1990 findings have clear practical implications for current methods of assessing cognitive abilities in children with Down's syndrome but they also provide some insight into the potential effects of motivational deficits on their development. The task avoidance and unstable performance observed in assessment situations could be representative of the approach of children with Down's syndrome to all learning, with poor engagement and insufficient rehearsal adversely affecting both the acquisition and consolidation stages of learning. By artificially enhancing success: failure ratios, teaching strategies such as errorless learning could perhaps play an important role in preventing avoidance becoming the routine response to difficult learning situations. A more 'balanced' experience of success/failure could result in children becoming less reluctant to reproduce the skills they eventually learn, thereby increasing the probability that these would be fully consolidated into the repertoire and be available for use whenever subsequently required .

Few studies have attempted to assess the longevity or carry-over effects of errorless learning, however. In the small number of case studies which have reported positive post-training results, there appears to have been little or no mention of the stability of the achievements made with this technique. The first of the two experiments to be presented here addresses this issue of stability by investigating whether gains achieved through errorless training are reliably demonstrated in subsequent testing sessions given one, three and six weeks after initial training. The second experiment evaluates the efficacy of errorless training as a device for teaching discrimination skills. It looks at what is actually learned through errorless training, investigates whether this can be successfully applied to learning a second discrimination task, and if so, with what degree of saving.

In summary, the aims of the present study were therefore:

1) to replicate the findings of the earlier errorless learning study with a wider age range of children with Down's syndrome,

2) to investigate the transferability of skills acquired through errorless learning,

3) to compare response to errorless training in two different groups of children with learning disabilities, children with and without Down's syndrome,

4) to investigate the longevity of gains made through errorless learning in these two groups.

Method

Experiment 1

Sample

Sixteen children with learning disabilities, eight with Down's syndrome and eight without, took part. Both groups of children were drawn from the same three Edinburgh special schools. The group of children with Down's syndrome consisted of four girls and four boys ranging in age from 6-16 years (mean 11.25 yrs). Age range of the five girls and three boys in the non-Down's syndrome group was 6-17 years (mean 11.5 yrs).

Sample Matching

In the 1987 study, direct mental age (MA) matching of the children with Down's syndrome and the non-delayed children was avoided on theoretical grounds, with matches made on the basis of performance on a task-related subject selection test. Because nonsense syllables were used here (see below), this was not possible in the present experiment. The two groups were instead matched on the basis of teacher ratings, with teachers informed of the aims of the study and asked to select children without Down's syndrome similar in general ability levels to the children with Down's syndrome already chosen for the study.

It was felt prudent to obtain a second measure of ability level in the event that two teacher-matched children performed very differently in the discrimination tasks but for reasons unrelated to the differing aetiologies of their learning disability. The accuracy of teacher matches was therefore assessed by determining MA levels for all children with the

Kaufman Assessment Battery for children (K-ABC) and comparing MAs across matches. Direct MA comparisons of two groups of learning disabled children, although by no means ideal, would seem less vulnerable to criticism than the practice of MA-matching learning disabled children with much younger non-disabled children. The differences in individual learning histories and of the possible effects of these on motivation are obviously likely to be considerably less in the case of two groups of learning disabled children than in the case of any 'match' of disabled and normally-developing children.

Procedure

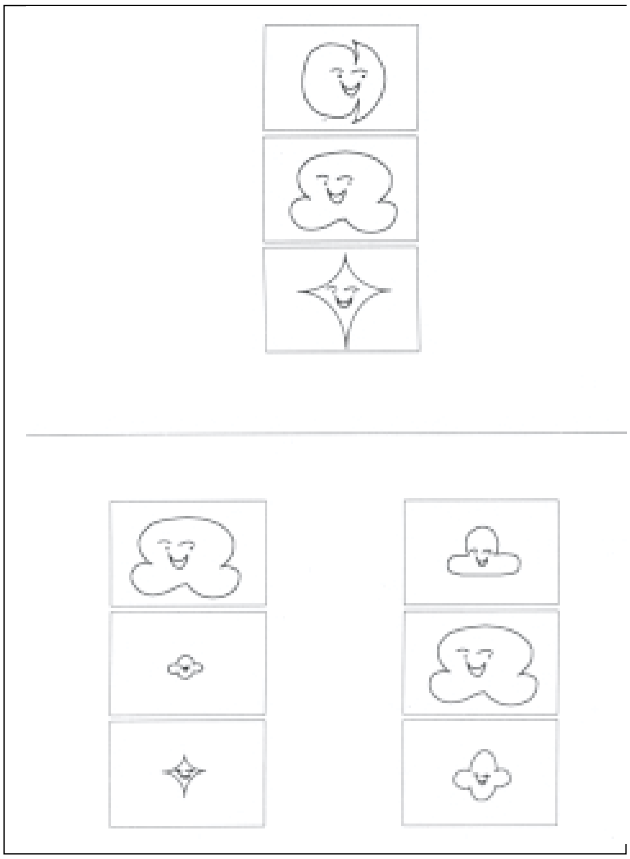
The experiments to be reported here differ in a number of ways from the original 1987 study. In the 1987 study, errorless procedures were used to teach discrimination of (a) a common geometric shape, and (b) a previously unseen nonsense figure. For two reasons, it was decided to use only nonsense stimuli in the present study: firstly, because this would avoid any possible confounding effects on test performance of differential levels of prior learning experience with the target discriminant (it could be guaranteed that all children were equally unfamiliar with the nonsense stimuli), and secondly, because this would allow investigation of the effectiveness of the errorless procedure in isolation from any possible effect of its interaction with experiential factors (it could be guaranteed that no child could have had any previous learning history - positive or negative - with the target figure).

The experiment took place over a six week period. In the first session, after being presented with a pre-test (see below), all children were trained with errorless learning procedures to discriminate the target stimulus from two alternative nonsense stimuli. A post-test was presented immediately following training.

Re-tests were administered one and three weeks later to both groups. In these sessions, children were retrained in the discrimination if they did not achieve 100% on the initial pre-test. Children with Down's syndrome were also retested on a third occasion, three weeks after the third session (i.e six weeks after initial training). Because of pressures on school time-tabling, this fourth testing session could not be given to the children who did not have Down's syndrome.

Testing took place in a small room, as free from distraction as could be arranged within the school settings. Child and experimenter sat opposite each other at a table. All tasks were presented using a similar format. Children were shown a drawing of Mr Plimp and told that he had some friends called 'wugs' in the pack of cards on the table. The aim of this game was to help Mr Plimp find all the 'wugs'. Trial sets consisted of one target stimulus - a 'wug' - together with two alternative nonsense figures (see Figure 1). In training the alternative stimuli were 'faded in' on the basis of size. Children were told "I am going to show you three cards with little men on them. I want you to point to the card which you think has Mr Wug on it." Each stimulus was presented on a separate white post-card sized card. In each trial the three cards were placed, one by one, on the table in front of the child. Children were required to select the target stimulus from each of these trial sets of three. Position of the figure to be identified was randomised over trials.

Figure 1. The 'wug' discrimination task: examples of the target and alternative stimuli used in Experiment 1 in pre- and post-test trials (top) and in training trials (bottom).



Pre- and post-tests: Although not included in the 1987 procedure, pre-tests were administered prior to training trials in the present study. There were again two reasons for this: firstly, because it would enable evaluation of within-session effects of errorless training and secondly, because it would provide a measure of the longer-term stability of skills learned in training (through comparison of pre- test scores obtained in sessions 2, 3 and 4 with post-test scores from session 1).

Pre- and post-test trials consisted of seven test card sets, each with a 'wug' and two other similarly sized nonsense figures. All nonsense figures were of different colours and approximately 7cm. along the longest dimension. Children's choices were not commented on in pre- and post-test trials.

Training Trials: Fifteen trial sets of three cards were used. Trials were presented in an order such that two alternative stimuli to the wug were gradually 'faded in', increasing in size while varying in shape over trials (see Figure 1). In trial sets 1 and 2, the target stimulus was presented with two blank cards. In these and all subsequent trials, position of the target stimulus was randomised over trials, as was colour, the latter a precaution against misidentification of this as a relevant attribute of the target stimulus.

Trial sets 3 and 4 consisted of a wug with two similarly-coloured but much smaller (0.5 cm) alternative figures. The dimensions of alternative stimuli were increased over each set of two trials until trials 11, 12 and 13, where size was increased and colour changed over each trial. These trials became increasingly more difficult as size of the alternative stimuli became similar to that of the target stimulus. The final two trials each consisted of three figures: a wug and two alternatives nonsense figures of equivalent dimensions.

Children were told “I am going to show you three cards with little men on them just as I did the last time and I want you to point to the card with the wug. This time I will tell you if you are right.” Verbal praise was given on behalf of Mr Plimp each time the child made a correct response. Errors were not commented on but, rather than proceeding with the next trial, the previous trial was re-presented, this procedure being repeated as necessary until the child had shown mastery of that particular step in the training sequence.

Experiment 2

Sample

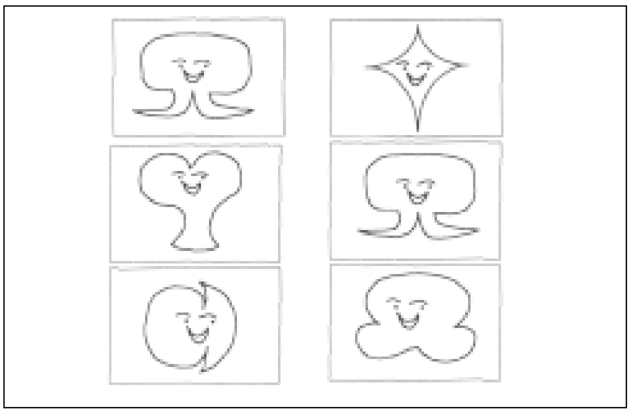
Seven of the eight children with Down’s syndrome from Experiment 1 took part in this study. Due to medical appointments, one child was unable to participate; he was replaced by a nine year old boy with Down’s syndrome who was first given training as in Experiment 1. This lowered mean age of the Down’s syndrome group to 10.3 years.

Procedure

Children were tested once weekly for three weeks on a new discrimination task. As in Experiment 1, an errorless procedure was used to teach the new discrimination in session 1 (after administration of the pre-test, and followed by the post-test). In the two subsequent sessions, re-training was given only where necessary (i.e. if pre-test scores were not 100% correct).

Procedure was identical to in Exeriment 1. Fifteen sets of cards were used, each including one ‘nim’ (the target stimulus), together with two alternative nonsense stimuli faded in over trials on the basis of size (Figure 2). One trial set in each of the pre- and post-tests included a ‘wug’ (the target stimulus from Experiment 1) as one of the alternatives.

Figure 2. The 'nim' discrimination task: examples of the target/alternative stimuli used in pre- and post-trials in Experiment 2.



Results

Experiment 1

All responses in pre-tests, training and post-tests were used in the analysis. Pre- and post-test scores were expressed as the number of correct responses made; training scores were expressed as percentages (correct responses / total responses).

Evaluation of Sample Matching

Performance in the initial session was investigated for differences that may have indicated any inaccuracies in matching across groups with and without Down’s syndrome. No significant differences were found between pre- or post-test raw scores attained by the two groups ($t = 0.406$, df 14, NS; $t = 0.457$, df 14, NS respectively - see Table 1). A further comparison of pre-/post-test differences in individual children also failed to reveal any trend favouring either group ($t = 0.114$, NS), indicating that for the purposes of this study, sample matches were satisfactory. Comparison of mental age scores attained on the K-ABC also revealed no significant differences between groups, adding further support to the validity of teachers’ original ratings of the general ability levels of the children in the two groups.

Table 1. 'Wug' discrimination. Effects of training on subsequent performance: pre- and post-test scores.

Children with Down's Syndrome							
Session	1		2		3		4
	Pre	Post	Pre	Post	Pre	Post	Pre
1	1	7	7	-	7	-	7
2	0	6	4	5	2	7	7
3	3	7	7	-	7	-	7
4	3	6	7	-	7	-	7
5	4	7	7	-	7	-	7
6	1	7	7	-	7	-	7
7	3	7	7	-	7	-	2
8	3	2	4	5	7	-	7
Children without Down's Syndrome							
Session	1		2		3		
	Pre	Post	Pre	Post	Pre	Post	
1	3	7	2	7	7	-	
2	1	7	7	-	7	-	
3	3	7	3	6	7	-	
4	2	5	2	7	7	-	
5	0	7	7	-	7	-	
6	6	7	7	-	7	-	
7	2	7	7	-	7	-	
8	4	6	7	-	7	-	

Training Scores: Table 2 shows the percentage of correct responses during training trials for Down’s syndrome and non-Down’s syndrome groups over the three sessions. Although both groups responded positively to the errorless strategy in the first session, t-test comparison of training scores in this session revealed a significant difference in favour of the group with Down's syndrome ($t = 1.974$, df 7, $p < 0.05$). It can also be seen from Table 2 that three children from each group required retraining in the second session, with one child with Down's syndrome requiring a third re-training. In all cases, however, training scores improved in these subsequent sessions, demonstrating at least some carry-over effect of earlier training.

Table 2. Percentage of correct responses during 'wug' training trials.

Session		1	2	3
Children with Down's syndrome	1	100	-	-
	2	80	93	100
	3	100	-	-
	4	100	100	-
	5	100	-	-
	6	100	-	-
	7	100	-	-
	8	80	90	-
Children without Down's syndrome	1	74	95	-
	2	100	-	-
	3	67	73	-
	4	85	100	-
	5	74	-	-
	6	100	-	-
	7	100	-	-
	8	67	-	-

Pre- and Post-Test Scores: Table 1 shows the effect of training on post-test performance in the same session and on pre-test performance in subsequent sessions. Improvement in performance in session 1 was calculated by comparing pre- and post-test scores. This difference was found to be highly significant, both when scores from the two groups were combined and when treated separately (combined groups: $t = 7.456$, df 15, $p < 0.0005$; DS group: $t = 4.651$, df 7, $p < 0.005$; non-Down's syndrome group: $t=5.657$, df 7, $p < 0.0005$). This initial comparison demonstrates the immediate carry-over effects of a single errorless training session on post-test performance and is consistent with the findings from the 1987 errorless learning study.

Pre-test scores attained in the two subsequent sessions provided a measure of the extent to which the discrimination had been retained over a weekly and over a fortnightly interval. No significant differences were found between scores achieved on the pre-test in session 2 and those in the post-test in session 1 either when the two groups' scores were combined or when taken separately (combined groups: $t = 1.3$, df 15, NS; Down's syndrome group: $t = 1.7$, df 7 NS; non-Down's syndrome group: $t = 0.3$, df 7, NS), indicating that the discrimination had been retained between the first and second sessions. Comparison of the results obtained by the two groups, however, suggested that the group with Down's syndrome may have benefited to a greater extent from the initial errorless training session: from Table 1, it can be seen that only one child with Down's syndrome produced a lower score in the second of the two sessions, two others showing score improvements; scores from three of the children without Down's syndrome by comparison were reduced in session 2, with only one child attaining a small improvement in performance. Evidence of retention of the discrimination was clearly demonstrated for both groups in the third session, however; again, no significant differences were found between pre-test scores in this session and post-test scores from session 1, either overall or for the separate groups. In this third session all but one child with Down's syndrome attained 100% on the pre-test. After retraining, this one child did succeed in correctly discriminating the wug in all 7 post-test trials and was able to repeat this high level of performance in the final pre-test administered three weeks later. As can be seen in Table 2, seven of the eight children with Down's syndrome had fully retained the discrimination over this second three week interval.

Experiment 2

Training Scores: Training scores are set out in Table 3. It can be seen that most children responded well to the change in target stimulus and were able to produce training scores in session 1 of an equivalent level to those achieved in the first training session in study 1 ($t = 0.894$, NS). This result suggests, however, that there was little transfer of skill between the two discrimination tasks. Had a skill been transferred, some savings in the number of training trials required for mastery of the second discrimination would have been expected.

Table 3. Percentage of correct responses during 'nim' training trials.

Session		1	2	3
Child	1	94	73	89
	2	94	Abandoned	74
	3	Abandoned	74	94
	4	100	100	100
	5	100	-	-
	6	100	-	-
	7	100	100	100
	8	100	100	-

In addition, it can be seen that although training scores in the second and third sessions were consistently high, many children did require re-training. Six received training a second time and five a third time, whereas in Experiment 1 only three children had required a second, and one a third training session, before reliably achieving 100% pre-test scores in all subsequent sessions. It will also be noted from Table 3 that 2 training sessions had to be abandoned. This is discussed below.

Pre- and Post-Test Scores: Table 4 shows the effect of training on pre-and post-test performance. Direct comparison of pre- and post-test scores attained in the first session yielded no significant differences ($t = 1.843$, df (7), NS). Whereas in Experiment 1 performance had significantly improved after a single training session, this effect was not found when the target stimulus was changed for the present study. Pre-/post test improvement in the first session of Experiment 1 was significantly higher than that achieved on this second discrimination task ($t = 3.308$, df (7), $p < 0.01$).

Table 4. 'Nim' discrimination. Effects of training on subsequent performance: pre- and post-test scores.

Session		1		2		3	
		Pre	Post	Pre	Post	Pre	Post
Child	1	4	6	3	5	6	7
	2	0	1*	0	-	0	4
	3	2	-	1	3	5	6*
	4	0	3*	1	6*	4*	7
	5	4	7	6*	6*	7	-
	6	7	7	7	-	7	-
	7	3	5	3	5	5	6*
	8	7	7	5*	6*	7	-

** Denotes sessions in which 'wug' was incorrectly selected.*

Due to the absence of any immediate carry-over effect to post-test performance in this initial session, it was not possible to repeat the investigation of longer-term effects carried out in Experiment 1. Instead statistical comparisons were restricted to those made directly between scores achieved in Experiments 1 and 2; all other comparisons made are qualitative in nature .

Not surprisingly, given that so few children had mastered the discrimination within the initial training session, pre-test scores achieved one week later were significantly lower than those achieved at the equivalent stage in Experiment 1 ($t = 4.223$, df 6, $p < 0.005$). Of the three children who had attained 100% in the first post test, two were unable to reproduce this high level of success in this second session, both having selected the 'wug' in the single trial in which it was presented as an alternative stimulus, and both repeating this selection in the subsequent post-test (see Table 4). The same two children did achieve 100% in the pre-test administered in week 3, having apparently dropped their tendency to select the 'wug'. With the exception of the single child who had achieved 100% scores throughout trials, however, the remaining children were clearly still unable to master this second discrimination. Pre-test scores in this third session were again significantly lower than those achieved in the third pre-test in Experiment 1 ($t = 3.333$, df (6), $p < 0.01$). Even after a third training session, two children still showed confusion between the previous and current target stimuli.

Discussion

These experiments aimed to replicate and to extend experiments presented in an earlier paper. In that paper errorless training was shown to be an effective method of teaching discrimination skills to children with Down's syndrome. Here, the errorless procedure was investigated firstly, for the longevity of it effectiveness in teaching a specific discrimination, and secondly, for its intrinsic value in teaching discrimination skills *per se*.

As expected, in both Down's syndrome and non-Down's syndrome groups, there was a significant carry-over effect from training to post-test performance in the first session. In almost 70% of cases, a single training session proved sufficient for children to select the correct target stimulus in all seven post-test trials administered immediately following training. With one exception, the remaining children, whilst unable to demonstrate full mastery of the discrimination, were nevertheless able to show a marked improvement in pre-test scores in subsequent sessions after exposure to errorless training. Findings from the 1987 study were therefore succesfully replicated, with an errorless training procedure once again being shown to be an effective method for teaching discrimination skills within a single teaching session.

Results also clearly showed that the majority of children were still able to discriminate the target stimulus succesfully in pre-tests given one week then two weeks later. The fact that seven out of eight children with Down's syndrome demonstrated retention of the discrimination when presented with a third re-test six weeks after the first training session is particularly encouraging, especially given that in most cases only one training session had been required. Teachers had indicated in preliminary discussions that children in both groups often required repeated teaching sessions when learning similar skills using conventional methods. These results suggest that for children with learning difficulties, both with and without Down's syndrome, skills taught in this way can not only be learned comparatively quickly but are also retained.

A clear difference did, however, emerge between the two groups in terms of their response during training. In the first session, children with Down's syndrome required fewer training trials to acquire the discrimination than children without Down's syndrome. Given that this difference was not significantly reflected in any subsequent session, nor in the amount of improvement made between pre- and post-test scores in the initial session, it would appear that these differences demonstrate a more positive response within the group of children with Down's syndrome to errorless training. This finding may reflect a stronger relationship between motivational factors and the demonstration of competence in performance in children with Down's syndrome than in children without Down's syndrome. As has been observed in previous studies (Wishart 1987, 1988; Wishart and Duffy, 1990), there were several clear examples of children with Down's syndrome at all ages 'switching on' social skills in non-training trials - apparently in an attempt to avoid the task in hand. Little evidence of the use of similar avoidance tactics was observed in the performance of those children in the study who did not have Down's syndrome.

Despite production of this type of behaviour by the children with Down's syndrome during testing, it proved to have little effect on the stability of their performance. Although there were children in both groups whose scores dropped between sessions 1 and 2, this was only found to occur for children with Down's syndrome when the discrimination had not been fully mastered in the initial session. All but one child with Down's syndrome, having attained 100% on a pre- or post-test, were able to reproduce this score in all subsequent tests. This was not always the case for children without Down's syndrome where a few quite severe score losses indicated that the discrimination, although apparently mastered in the first session, had not been retained. This trend in favour of greater stability of performance among the children with Down's syndrome occurred in spite of the tendency among children in this group to try to divert attention away from the tasks. Although still in evidence, motivational factors seemed to have a far weaker effect on overall performance within this learning context than in other situations (see also Duffy, 1990).

Although findings from Experiment 1 highlight the possible effectiveness of success-only strategies in increasing the reliability of performance in children with Down's syndrome, results from the second experiment were considerably less encouraging. The majority of children, despite responding equally well in initial training with the new target stimulus, were unable to maintain the high level of subsequent pre- and post-test performance demonstrated in Experiment 1. A small number of children moreover had severe difficulty in making the transfer within training itself. In two cases sessions had to be abandoned, children having become 'stuck' on several trials, repeatedly selecting an incorrect figure. Unlike Experiment 1, it did not prove possible in these cases to rectify these errors through re-presentation of the previous trial; often a pass on initial presentation would be followed by a fail when the same trial set was returned to a second time. In many cases these failures did not appear to be genuine but rather to reflect an almost defiant refusal to comply with the procedure. This represents a strong contrast to children's initial responsiveness to the first training in Experiment 1. The carry-over effect within training scores also disappeared in some cases, with children attaining lower scores in the second and even third sessions than in the first.

Why should the procedure which had proved to be so effective in the first experiment produce such comparatively poor results with this second task? Given that in both experiments training procedures had been identical, with alternative stimuli 'faded in' on the basis of size, it seems very unlikely that the second discrimination was intrinsically any more difficult to master than the first. A particularly prevalent characteristic of performance which emerged in the first post-test of some children and was still in evidence in some final sessions may provide an explanation. In many cases, although correctly selecting the 'nim' in 6 out of 7 post-test trials, children showed a clear preference for the 'wug' in the single trial set in which it was presented. For some reason the original discrimination was given priority over the new one. Previous research with the fading technique (Gollin and Savoy 1968) has suggested that it does not provide sufficient comparative experience to permit transfer because it tends to confine children' attentional responses to specific attributes of the target stimulus.

Bijou (1977) and Schilmoeller and Etzel (1977) have similarly pointed to the overuse of non-criterion related cues as an explanation for poor transfer (in the present study this would be the size of the target stimulus). The predominant focus on successful responses in errorless procedures is such that children are not required to identify the characteristics of any alternative stimulus in order to distinguish it from the target stimulus. Selection of the target stimulus is guided in initial trials through fading, and through recognition in later trials. It is possible therefore to achieve 100% success in training without necessarily having to attend to the alternative stimuli - that is, the procedure can teach children how to identify which of the three figures is the correct choice, but not why the remaining two are incorrect.

On this basis, it could be argued that although the second training task enabled identification of the 'nim' as the new target stimulus, by its very nature the errorless procedure precluded the possibility of learning that the 'wug' now represented an incorrect response. The identical nature of the training task and the occasional appearance of the 'wug' may have implied that the original stimulus was still relevant in some way. If children were simply responding to the non-criterion size cue in training in both tasks, it is not difficult to see how they could have become confused between the new stimulus and the original stimulus. This interpretation would suggest that rather than fully learning a discrimination skill, children were learning a task-specific strategy for making correct responses.

Evidence from a study of object concept development in children with Down's syndrome indicates that this tendency to adopt superficial task strategies may be characteristic of the approach of the child with Down's syndrome to learning in other areas of development (Wishart, 1990, 1993). Rather than using what has been learned at one level to step up to a more advanced level, the inappropriate transfer of response from one task to another seems to imply that very little true learning is actually taking place. In the present experiment, the same *strategy* was appropriate for both tasks but the specific response learned through use of this strategy in the first task was *not* appropriate to the second task.

This use of task-specific strategies lends support to Morss' suggestion that learning in children with Down's syndrome may be incomplete (1979). Given that Morss based this contention on children's apparent failure to appreciate the significance of error in learning situations and on their tendency to avoid learning situations in which failure was likely to be encountered, a need for extreme caution when using a technique such as errorless learning is indicated since this actually precludes erring. A failure to appreciate the significance of errors may prevent a full understanding of success when it does occur. If children with Down's syndrome are naturally devising a series of superficial tactics for minimising failure, overuse of techniques which operate on similar principles may simply reinforce their belief in the efficacy of this approach.

However, if due to an exaggerated experience of failure, children with Down's syndrome are reluctant to demonstrate particular skills during the initial stages of their acquisition, it is equally unlikely that any successes achieved will be fully capitalised on. It has been demonstrated here that experience of repeated success though errorless learning both improved children's performance on a task that did involve the possibility of failure *and* increased the likelihood of reliable production of correct responses in the longer term. Perhaps in the case of children with learning difficulties, it is more important to ensure success, whether or not it is initially fully understood, in order to increase the probability that new skills will be reproduced and used. Even if the use of success-only techniques does encourage the adoption of task-specific strategies, such techniques could nevertheless provide a 'baseline' of repeated success, generally not as readily achievable in conventional trial-and-error learning situations. Having confidently 'mastered' a skill through repeated success, the child may then be in a better position to deal with the errors necessary for the completion of the learning process.

Although results from the present study imply that what was 'learned' through use of the errorless approach was of little value in terms of discrimination learning *per se*, the technique may yet be of considerable relevance with respect to what children learn from the experience of learning itself. The intrinsic value of errorless training may not be in its use as a teaching device, but in persuading children to perform to full potential. Enhanced performance on conventional tasks might be achieved by using a combination of errorless and trial-and-error teaching methods. In discrimination learning, for example, having first learned through errorless training which is the correct response in a particular task and having learned to reliably and consistently select the correct target, the child could then be taught to relinquish that specific response and to learn why it is the incorrect response in another task through the use of trial and error methods. It may be possible in this way to reduce the influence of motivational deficits in determining the learning 'style' of children with Down's syndrome and to increase the stability of their performance in learning contexts. This in turn could increase the likelihood that what can be learned will be properly consolidated into the repertoire, available for use whenever subsequently needed.

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Address for correspondence:

Edinburgh Centre for Research in Child Development,
Department of Psychology,
University of Edinburgh,
7 George Square,
Edinburgh, EH8 9JZ,
Scotland, U.K.