Learning with and without errors in students with ASD

Aprendizaje con y sin error en estudiantes con TEA

María MORALO. Teacher. IES San Roque de Badajoz *(maria_moralo@hotmail.com)*.

Manuel MONTANERO, PhD. Professor. Universidad de Extremadura *(mmontane@unex.es)*.

Abstract:

Errorless learning is one of the most widely used didactic approaches in the teaching of students with Autism Spectrum Disorders (ASD). The main aim of this work is to analyse the performance in verbal labelling and sequential thinking tasks of children with ASD who follow this method. The activities were structured using a protocol approach of discrete trials training (DTT) with manipulative materials (cards to be matched or ordered). Two teaching approaches were compared: one comprising errorless learning (in which physical prompting was used to prevent the subject from making mistakes) and one involving errors (in which mistakes were permitted and corrected, with the appropriate help). Observation records showed significant differences in sequential thinking tasks, where less skilled subjects achieved poorer results in errorless learning conditions. The approach based on a structured sequence of feedback support when the student made errors led to a slightly higher number of correct answers but also some repeated errors. Finally, the implications of these results for the design of learning sequences of students with ASD are discussed, along with the main limitations of the study.

Keywords: errorless learning, self-regulated learning, feedback, verbal labelling, sequential thinking, autism, special education classroom.

Resumen:

El aprendizaje sin error es uno de los principios didácticos más extendidos en la enseñanza a personas con trastornos de espectro autista (TEA). El principal objetivo de este trabajo es analizar la ejecución de tareas de etiquetado verbal y pensamiento secuencial de niños con TEA, siguiendo dicho método de aprendizaje. Las actividades estaban estructuradas con un formato protocolizado de *entrenamiento en ensayos separados*

con materiales manipulativos (tarjetas que debían emparejar u ordenar). Se compararon dos condiciones instruccionales: una de aprendizaje sin error (en la que se empleaba la instigación física para evitar que el sujeto se equivocara) y otra con error (en la que se permitía cometer errores y rectificarlos, con la ayuda adecuada). Los registros de observación mostraron diferencias significativas en las tareas de pensamiento secuencial, donde los sujetos de menor competencia consiguieron menos aciertos en la condición de aprendizaje sin error. En general, la propuesta instruccional basada en una se-

cuencia estructurada de ayudas de *feedback,* cuando el estudiante se equivocaba, generó un número mayor de aciertos, aunque también un número ligeramente superior de errores repetidos. Finalmente, se discuten las implicaciones de estos resultados de cara al diseño de secuencias de aprendizaje de alumnos con TEA, así como las principales limitaciones del estudio.

Descriptores: aprendizaje sin error, aprendizaje autorregulado, *feedback,* etiquetado verbal, pensamiento secuencial, autismo, aula especial.

1. Introduction

Self-regulated learning activities, in which students have the chance to review their errors with the necessary help, are very important educational experiences for people with and without disabilities (Boekaerts, 1999; Cuskelly, Zhang, & Gilmore, 1998; Vieillevoye & Nader-Grosbois, 2008). Students with autism spectrum disorders (ASD), however, show distinctive *executive functioning* disorders (Burgess, 1997) that limit their ability to adapt to changes in their environment and self-regulate their behaviour (Martos-Pérez, 2005; Riviére & Núñez, 1996; Russell, 2000). These difficulties manifest themselves in stereotypical and repetitive behaviour in various activities in everyday life and in a lack of strategic behaviour, that is, sequences of actions consciously aimed at attaining a goal (Kaplan, 2008; Ozonoff, Strayer, McMahon, & Filloux, 1994).

Nonetheless, with the appropriate educational and environmental support, people with ASD can develop self-regulatory capacities at varying levels depending on their disability and their particular needs (Martín, Hernández, & Ruíz, 2007). To do this, it is necessary to create a sufficiently predictable and structured environment with visual cues and other types of material and personal resources to facilitate the anticipation and comprehension of activities. In addition, interventions adapted to meet the needs of each individual may be required, whether these be biomedical, sensory-motor, psycho-educational, or behavioural (Weiss, Fiske, & Ferraioli, 2009).

This last type of intervention is principally aimed at facilitating functional learning of skills using various modelling, chaining, immediate reinforcement, etc., techniques that have proven to be useful

with students with ASD (Martos-Pérez & Llorente-Comí, 2013; Mulas et al., 2010). The activities are structured in brief learning sequences that are repeated as often as needed, as is done in the *discrete trial training* (DTT) approach (Lovaas, 1981; Thomson et al., 2009; Smith, 2001).

One of the principles that frequently guides the design of these activities is *errorless learning*. This essentially involves providing a type of feedback in highly structured learning tasks in such a way that at all times the student is prevented from making errors (Touchette & Howard, 1984). This principle derives from the fact that people with ASD tend to *fix* in their memory any errors they make in the learning process to an unusual extent, to the extent that it can get in the way of the acquisition of certain skills, such as reading, or the acquisition of concepts, and so it is advisable to avoid errors (Etzel & LeBlanc, 1979).

So, for example, in the feedback technique known as *most-to-least* (MTL), the educator sequences learning aims in more specific or progressively more complex actions. The teacher starts by physically guiding the process of doing a task, directing the student's hand with her own while performing the action so the student does not make any errors. The physical help is gradually withdrawn as the action becomes automatic, and backward chaining begins. The physical guiding is reintroduced as often as necessary until the objective is achieved. If the task is broken down into short attempts (as in the DTT approach), the chances of failure are reduced (Smith, 2001).

In comparison with other similar strategies, like no-no-prompt (in which students are permitted to make errors up to two consecutive times when performing a task) or the instructive-feedback technique (which does not explicitly avoid errors), it has been shown that MTL reduces the probability of failure and increases the likelihood that the skill learnt will be retained over time, but it does not favour autonomy and self-regulation of the learning process and can be less effective than other alternatives (Fentress & Lerman, 2012).

Despite their extensive use in interventions with people with ASD, we do not yet have sufficient proof of the effectiveness on curriculum content of errorless learning approaches. The strategies described above benefit some subjects but not others, this depending on a range of factors (Delmolino, Hansford, Bamond, & Fiske, 2013). The studies that report positive results usually integrate errorless learning into relatively broad intervention programmes or technologies, such as ABA-applied behavioural analysis, that combine various types of strategy (Artoni et al., 2017). Consequently, it is difficult to discern what influence it really has on results. The data are often of poor quality and also generally allude to behavioural or socio-communicative skills (Mottron, 2017). The limited research that has specifically compared trial and error learning with errorless learning in certain curriculum tasks (such as basic arithmetic operations) has even reported notably worse results for the latter approach (Leaf et al., 2010).

Consequently, it appears to be necessary to continue research into the conditions that facilitate the efficacy of this type of educational procedure, as well as the risks or opportunities for learning that error represents for students with ASD. Accordingly, this work has two main aims: firstly, it aims to analyse the effectiveness of a highly structured process of errorless learning among students with ASD in specific curriculum tasks (namely, verbal labelling and sequential thinking). Secondly, it aims to explore the efficacy of an alternative procedure for identifying and self-correcting errors, with material and verbal help that can be implemented easily in special classrooms.

2. Method
2.1. Participants

Four students with Autism Spectrum Disorders (ASD), aged between 5 and 8 and educated in the *special class* of a mainstream primary school, took part. Once the appropriate consent was obtained and the ethical and confidentiality commitments were signed, the students were selected by convenience, in accordance with the following criteria:

- Having an ASD diagnosis (with a score of under 50 on the IDEA scale) in an official educational psychology report prepared by the local educational psychology team, without other intellectual or sensory disabilities also being present.
- Being aged 5 or over and under 9 and studying in the third year of early childhood education as a minimum.

- Displaying oral language with sentence structure.
- Having literacy skills and the capacity to analyse language.

A teacher who specialises in therapeutic pedagogy from a public school in Badajoz also took part in the study. As well as over five years' professional experience in educational support tasks for students with ASD, she has broad pedagogical training in a variety of educational support techniques for these students, in particular teaching curriculum content.

2.2. Design

The research was based on a multiple observational design. Two working groups were set up, depending on the curriculum level of the subjects. The level I group comprised 2 children (J. and R.) of 5 and 6 years of age respectively, and one level of curricular competency: year three of early childhood education. Level II comprised a boy and a girl (A. and P.) of 7 and 8 years of age, with a curricular competency level of year one of primary school.

The sessions took place in a *special classroom* for students with ASD, individually and face-to-face. They focussed on verbal labelling and sequential thinking tasks. The subjects' performance with two teaching approaches (*trial and error* and *errorless*) was compared using the number of correct answers and errors in each task. The activities were structured using a *discrete trial training* protocol approach with manipulative materials (cards to put in pairs or in order). In the *errorless* learning mode, if

the teacher noted that the student was about to make a mistake, she used physical guidance, moving the student's hand towards the correct card. In the trial and error learning approach, however, students were allowed to make mistakes and a variety of material and verbal help was provided (listed below).

As two competence levels were worked with, a total of 8 learning activities were designed. These are summarised in Table 1.

TABLE 1. Distribution of learning content in the teaching approaches.

Approach	N	Errorless learning		Trial and error learning	
Task		Verbal labelling	Sequential thinking	Verbal labelling	Sequential thinking
Level I	2	16 concrete and familiar concepts.	8 series of 3 geometric shapes (one joint variable and another differentiating one).	16 concrete and familiar concepts.	8 series of 3 geometric figures (one joint variable and another differentiating one).
Level II	2	8 less concrete and familiar concepts.	4 temporal sequences of 5 to 6 sketches representing everyday events.	8 less concrete and familiar concepts.	4 temporal sequences of 5 to 6 sketches representing everyday events.

Source: Own elaboration.

The content of the activities (of equivalent difficulty in both approaches) had not previously been covered in class. All of the students took part in both teaching methods, starting with the errorless learning method. This decision was taken to avoid potential extraneous variables relating to learning new strategies, as the students had always followed the errorless learning method in the classroom when working on verbal labelling and sequential thinking tasks with other conceptual content.

2.3. Materials

Various cards and work sheets were designed for doing the learning activities in both the errorless and trial and error approaches. These are described below:

2.3.1. Verbal labelling tasks

At the first level, 32 concrete and familiar concepts were covered in verbal labelling: 16 for the errorless approach and another 16 for the trial and error approach. In both teaching approaches, the words used to express these concepts had the same number of syllables (from 2 to

4). To prevent reading errors when using the direct lexical route, none of the words in either teaching method started with the same syllables. Each of the concepts selected was represented with a picture and a word written on two laminated cards: 16 picture cards and 16 word cards for each teaching method. In addition, for the trial and error learning method, another 16 *correction cards* were prepared, with the image from the picture card and the concept from the word card below it. In other words, the final result of associating the picture card with the correct word card.

At level II, another 16 concepts were covered (8 in each approach). These were also selected at random, but were more abstract and less familiar than at level I. As the subjects had already acquired based literacy skills, the dynamic of the activity was also somewhat more complex. The concepts were worked on in pairs, matching opposing concepts. Instead of representing one single concept, as in the previous level, the picture cards showed a pair of antonyms (for example, in the case of the *light* and *dark* concepts, there would be a dark red book on one card and a light red book on the other; two other cards would show a light blue comb and a dark blue one, etc.). In the trial and error teaching approach, flash-cards were used instead of the word cards (for each pair of concepts to learn). The flash-cards represented the concepts using images based on the *Picture Exchange Communication System* (PECS). For example, for the concepts of light and dark, the flash cards were two laminated cards, one dark

grey and the other light grey. All of the flash-cards are stuck to a sheet of blue cardboard to make it possible to identify them clearly.

2.3.2. Sequential thinking tasks

To teach sequential thinking at level I, 16 work sheets were used, each showing a series of 3 geometric shapes (8 cards for the errorless learning approach and another 8 for the trial and error approach). The series of geometric shapes shared one common variable (the geometric shape) and another differentiating variable (the colour). At the top of the card, there was a model-series the students have to try to repeat (for example, three squares and inside them a blue triangle, a green triangle and a red triangle). At the bottom of the card there was a block with nine empty cells (a similar pattern to the one in the upper part, but empty), where the student had to repeat the model series. The series to work on each day were picked at random. In addition, for the trial and error learning approach, 4 correction series were prepared with the correct series of geometric shapes already in place and stuck down.

Instead of geometric shapes, level II involved working on sequential thinking with 8 temporal sequences from a story (4 sequences for each method). To do so, the *Schubi 1 and Schubi 2 temporal sequences* speech therapy material was used with 5 and 6 cartoons per sequence. A series of cartoons portrayed, for example, a man sitting down on a sofa to read the newspaper and sitting

on a cat because he has not seen it. The allocation of sequences was done at random, but using the same number of cartoons in each method. In addition, in the trial and error learning approach, *correction cards* were prepared with the sequence of cartoons already in the correct order.

2.3.3. Evaluation record

To evaluate the process and learning outcomes of the two teaching methods (trial and error and errorless), a direct observation record was kept. This comprised a table on which the name of the student, session number, and type and level of the task to be worked on were listed before the start of the session. At the end of the session, the number of correct answers given by the student was noted down. We also recorded the number of new and repeated errors and how often effective help (leading directly to a correct answer) and ineffective help (leading to a new error) were given. Finally, in a small space provided for this purpose, qualitative comments were noted down as required about the task in which the students made some kind of error (whether it was an initial task or a review one; which particular concepts or sub-tasks errors happened in; what type of help in accordance with the sequence set out in Table 2 was effective; and possible unusual behaviour or critical incidents).

2.4. Procedure
2.4.1. Verbal labelling sessions

Each level I student worked individually on verbal labelling tasks for 4 sessions per week up to a total of 32 (16 ses-

sions with errorless learning and another 16 with trial and error learning, including the revision activities). At level II each of the students performed 3 sessions per week (one day working on classifying concepts, one on identifying them, and another on naming them). In total, there were 24 sessions (12 with errorless learning and 12 with trial and error learning). Each session lasted approximately 5 minutes.

Level I

The procedure for carrying out the sessions at the lower level of difficulty was always the same:

1) The first picture card was presented and the corresponding word said aloud, then the word card was presented straight away, and the sequence was repeated with a second word.
2) The 4 cards were removed from the table and the two picture cards were again presented, while at the same time each word was said aloud.
3) A picture card was presented with the instruction «put it down», so the child would place it below the corresponding picture card, and then the subject was offered the other word card to do the same.

In the errorless learning method, the student was not permitted to make mistakes when matching the word card to the corresponding picture card. Before the student could link them incorrectly, the teacher would take his or her hand while repeating the written word, and would then move it towards the correct

card or position; once they were correctly linked the student would be asked to read it.

In the review activities, the working dynamic was different. The students were shown two picture cards (with the teacher reading the verbal label aloud) and a single word card that the student had to link. After associating the first picture with its word, another picture card was placed on the table so that there were always two pictures present. This process was repeated until all of the words previously covered had been reviewed. As before, the student was not allowed to make any errors when associating the word card with the corresponding picture card, and so before the student could link them the teacher would take his or her hand and guide it towards the correct position while repeating the written word.

In the trial and error learning approach, the concept introduction sessions followed the procedure described here for the errorless learning method. The only difference was that possible errors in the drawing-word association were not prevented. When this happened, they were shown a different card *(correction card),* which showed the correct drawing-word relationship, so that they could correct it. If they did not correct themselves, the teacher would provide simple help by focussing attention on the card. When the students made the correct association, they would be asked to read the word.

During the review, the working dynamic was also very similar to the one

described for errorless learning, with the exception that, if the subject made a mistake, the teacher would show the correction card. This process was repeated until all of the words covered in previous sessions had been reviewed, and so, as the sessions advanced, the number of words to review increased.

Level II

At the more advanced level, the sessions were split into three phases: classifying, identifying, and naming opposite concepts.

- In the classification phase, two trays were provided into which the picture cards being worked on would be placed (for example, the wide-narrow concepts). The teacher would first show a flash card with a drawing representing the concept (wide), say the name of the concept aloud, and put the card in one of the trays. Next, she would show the other flash card (in this case representing the concept narrow), say its name aloud, and put it in the other tray. After this, the teacher showed each picture card and said its name aloud, but the student would put them in one tray or the other, as appropriate until all 24 picture cards had been used (12 representing the concept narrow and the other 12 the concept wide, in this case).
- Once the students had done the classification without errors, they moved on to the identification phase. Using the instruction «give me…», the student was asked to hand over one of the cards from one concept or the other (they

had already been classified into trays), to be sure the student had correctly absorbed the verbal label corresponding to this concept. Continuing with the previous example, the instruction would be: «give me wide», «give me wide», «give me narrow», etc. The students were asked for the picture cards one at a time and at random until they had all been handed over.

• Finally, the naming phase took place, in which the students themselves said aloud the name of the concept, before placing it on each of the trays.

In the errorless learning approach, the student was not allowed to make errors in any of the phases; before erroneously classifying or naming a picture card the teacher would take the student's hand while saying the written concept aloud and physically guiding their hand towards the correct option.

In the trial and error approach, if the students made a mistake in the classification, they would be shown a correction card (different from the previous ones), which showed whether or not it corresponded with this tray, and they would be given time to self-correct. If the student did not do this, more help would be given.

2.4.2. Sequential thinking sessions

Sixteen sequential thinking sessions were carried out at each level (8 with each approach), divided into two sessions of about 5 minutes per week. In the second weekly session, the series from the first one was covered again.

Level I

At the lower difficulty level, before starting the activity, it was reviewed by jointly pointing (holding the student's finger) at the model-series to be done, which appeared at the top of each card. For example, with the instruction «blue, green, red» (while identifying each shape in the model series), the teacher would say «now put it down» (letting go of the student's hand so he or she could start working). Next they were given the necessary stickers to reproduce the series (several sheets with stickers of the shapes that made up the model series, but out of order). As the sessions advanced, more sheets to choose from were provided.

In the errorless approach, before unsticking an incorrect geometric shape from the sheet, the children were redirected towards the model (accompanied by the instruction: «blue, green, red») so they could visualise the correct colour and the movement was modelled so that the correct colour would be selected.

In the trial and error learning approach, when they were finishing the series, in other words, when the students had stuck down three shapes, they would be helped to put it just above the pattern they were completing (giving them the instruction «take it» and showing them the correction series). This step was done whenever a series was completed, whether or not there was an error. If they did it well, they were given reinforcement (for example, «how have you done it? Well done, that's great!»).

If students spontaneously realised there was an error, they were allowed to correct it, removing the shapes where they had gone wrong. After this, the correction pattern was removed so that the students could only place the geometric shapes by following the example of the model series. If students did not realise there was an error, they would be given a series of types of help, in the order shown in Table 2, until they managed to correct it.

Level II

At the more difficult level, two stories with five pictures and another two stories with six were used that the student had to put in order. The session started with the instruction: «We are going to work on sequences. First, look at them all, and then we will put them in order. First, which one?» Once the correct order of the sequence had been completed, the subject was asked to describe what had happened in the story (with the previously mentioned structure: first…, second…, third…, and finally…).

In the errorless learning approach, before children could pick up the wrong sketch, their hand would be guided to the previous sketch, which was already correctly placed, with the instruction «look closely here…».

In the trial and error approach, the subjects were given as many consecutive instances of help as needed, in the order shown in Table 2, until they placed the correct drawing.

2.5. Evaluating the process and learning outcomes

During the sessions described above, each of the correct answers and errors given by the students and any help they received was recorded on paper. It should be noted that while in the errorless approach the children did not actually make errors, these could be detected in their initial intention.

Given that the concepts covered in the verbal labelling tasks were covered again cumulatively in the following sessions, two different types of error were differentiated: new ones (with words introduced for the first time in each session) and repeated ones (with words that had been presented previously).

3. Results
3.1. Verbal labelling

Overall, the students gave a slightly higher total percentage of correct answers in the trial and error learning approach during the verbal labelling tasks (Table 3), although the differences were not statistically significant.

The students from level I (with less curricular competence) gave the right answer 96.9% of the time when matching the picture cards and word cards over the 16 sessions in the trial and error learning approach, and 93.4% of the time in the errorless learning approach.

In the errorless learning approach, most of the errors made were new ones: 5.6% compared with 1% new errors in the

TABLE 2. Sequence of help in the trial and error learning approach.

Help	Description	Example of verbal instruction at level I	Example of verbal instruction at level II
Focusing with description by the student (FDS)	The teacher directs the child's attention to a relevant clue and asks for a description, while jointly indicating (holding the child's finger) the misplaced element in the sentence.	«Look closely, what colour is this triangle?»	«Look closely, what is the cat's belly like here?»
Focussing with description by the teacher (FDS)	The teacher directs the child's attention to a relevant clue, while jointly indicating it and simultaneously describing it.	«Look, this triangle is green.»	«Look, here the cat has a big belly.»
Comparison with description by the student (CDS)	The teacher jointly indicates and asks the student to compare two elements (at level I the erroneous shape with the one from the model series, and at level II the erroneous cartoon with the one that comes immediately before in the sequence), letting the child complete a phrase.	«Here the triangle is … and you've put …»	«Here the cat has … And in this one the cat has …»
Comparison with description by the teacher (CDT)	The teacher jointly indicates and compares two elements (at level I the erroneous shape with the one from the model series, and at level II the erroneous cartoon with the one that comes immediately before).	«Here the triangle is green, and you've put red.»	«Here the cat has a big belly, and here it does not any more.»
Comparison with explanation by the student (CES)	The teacher jointly indicates and compares two elements, while simultaneously asking for an explanation of the relationship between them.	«Why have you put the red triangle here?»	«Why does the cat have a big belly here but not here?»
Comparison with explanation by the teacher (CET)	The teacher jointly indicates and compares two elements, while simultaneously explaining the relationship between them.	«Here the triangle is green and here it is too.»	«Here the cat has a big belly, but here it does not because it has had kittens.»
Error identification (EI)	An error is jointly indicated and the student is encouraged to correct it.	«Take it off.»	«Take it off.»
Correction by the teacher (CT)	The error correction was moulded with physical guidance (at level I) and the subjects were shown the correct sequence (level II).	«Take it off.»	«Look.»

Source: Own elaboration.

TABLE 3. Total correct answers and errors in all of the verbal labelling sessions.

Teaching approach	Result	Level I		Level II	
		J.	R.	A.	P.
Errorless learning	Correct answers	133	136	140	142
	New errors	9	7	4	2
	Repeated errors	2	1	0	0
Trial and error learning	Correct answers	138	141	141	144
	New errors	2	1	3	0
	Repeated errors	4	2	0	0

Source: Own elaboration.

trial and error learning approach. In contrast, the percentage of repeated errors in the review activities was slightly higher in the trial and error learning approach (2.1%, compared with 1% in the errorless approach). In other words, the students made fewer errors but the ones they did make were more persistent than in the trial and error learning approach. For example, in the trial and error learning approach, J. made a mistake with the word «banana» and repeated this in several review sessions. The same thing happened to R. with the word «sandwich». In both cases the children were able to self-correct the error.

In the level II group (with greater curriculum competence), the students gave 99% correct answers in the trial and error learning approach and 97.9% in the errorless learning approach. All of the errors were made in the classification phase and none during the review. If we exclude the first verbal labelling session in level II, the overall performance of the subjects was very similar in both learning approaches.

The only type of help given in both levels (on 12 occasions) was *focussing with description by the stvudent* (see Table 2), after which the subject always managed to correct the error.

TABLE 4. Total correct answers and errors in all of the sequential thinking sessions.

Teaching approach	Result	Level I		Level II	
		J.	R.	A.	P.
Errorless learning	Correct answers	54	53	40	37
	New errors	18	19	4	7
	Repeated errors	0	0	0	0
Trial and error learning	Correct answers	66	66	40	38
	New errors	6	6	4	6
	Repeated errors	0	0	0	0

Source: Own elaboration.

3.2. Sequential thinking

Table 4 shows the overall results obtained in both approaches for training sequential thinking, using the trial and error and errorless approaches, throughout the 8 working sessions.

As in the previous task, students gave more correct answers in the trial and error learning approach: 91.7% (compared with 74.3% in the errorless approach) in the case of the students from level I, and 88.6% (compared with 87.5%) in the case of the students from level II. The main differences between the two teaching approaches regarding success in ordering the sequences were mainly observed in the period corresponding to sessions 2, 3, and 4 at level I, a level where the difference between the average number of correct answers in the errorless learning sessions (6.7) and in trial and error learning (8.3) was significant (Z = 2.46; p = 0.014). In contrast, at level II the difference is not significant.

No errors were repeated in either approach. Although the level I students made some errors in the review activities, these did not coincide exactly with the ones recorded in the previous sessions with the same content, and so they were classed as new errors.

The set of types of help recorded was more varied than in the verbal labelling tasks. As shown in Graph 1, the most frequent types of help were also *focussing with descriptions by the student* (FDS). At level I, 12 instances of this type of help were recorded (83.3% of which led directly to self-correction of the error). In addition, 2 cases of *focussing with description by the teacher* (FDT) were also recorded, as well as 2 *comparisons with description by the student* (CDS), and 2 *comparisons with description by the teacher* (CDT), although only the last type was effective. At level II, 10 FDS were given (with an effectiveness of 50%), 5 FDT (40%), 3 CDT (66.6%), and 1 *comparison with explanation by the student* (CES) (100%). No explicit *error identification* (EI) or *correction* (CT) by the teacher was required.

GRAPH 1. Total effective and failed help in all of the sequential thinking sessions.
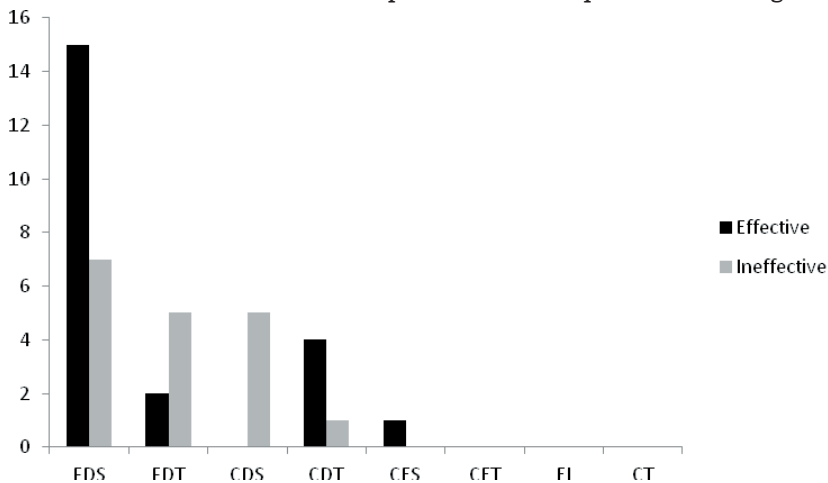
Source: Own elaboration.

4. Conclusions

Overall, the above results show the usefulness of highly structured *discrete trial training* processes in curriculum tasks based around verbal labelling and sequential thinking with students with an Autism Spectrum Disorder (ASD). In general, the students made few errors, especially in the verbal labelling tasks[1], and in the final sessions they achieved success rates close to 90%.

Although the differences between the trial and error and errorless learning approaches were very small among the students at level II, in the sequential thinking task we found a significant difference between the average number of correct answers recorded at level I, in favour of the trial and error learning approach. This result suggests that students with ASD can benefit from very basic self-regulated learning situations, where they are helped to review and correct their own errors in logical sequencing tasks (geometric shapes) and pragmatic tasks (stories). To do this, instead of error avoidance and physical guidance, correction cards were used, as well as a feedback assistance sequence protocol. Low-intensity help, like simply focussing students' attention on certain visual keys in the task, was sufficient on most occasions for the student to complete the self-correction process successfully.

While it is true that the number of *repeated errors* was somewhat higher with the trial and error learning approach, it was still very low, and so we cannot conclude that there is greater vulnerability

deriving from being allowed to make mistakes.

Ultimately, the results at the very least cast doubt on the advisability of systematically using *errorless learning* procedures with curriculum content, as is often done in educational intervention with people with ASD. It appears that further research is required into which conditions make the possibility of making an error a risk and which ones make it an opportunity for better quality learning when the appropriate help is provided.

The conclusions of this research should, however, be treated with caution, owing to the methodological limitations inevitably present in a study in this field. The main limitations relate to the small number of participants, as is often the case in research into ASD. While we took a relatively large number of measurements of the execution of the tasks by the students, we cannot guarantee that we controlled for certain extraneous variables.

In addition, the difficulty of implementing a procedure to balance the two learning approaches in each task, for the reasons explained above, creates a clear threat. The main differences observed between trial and error and errorless learning approaches were concentrated in the first sessions for training sequential thinking in level I. This is a logical reasoning task with some comprehension challenges. As the subjects were previously exposed to the errorless learning method, it could be assumed that familiarisation with the task might have subsequently benefitted

the execution of similar tasks in the trial and error learning approach. However, it is important to note that before starting the research the students were already familiar with doing this type of task, as they had done them previously in the errorless approach with similar content, and so this potential extraneous variable should not have a significant effect on this matter. In future studies, however, it would be advisable to expand the sample of participants, as well as the quantity and quality of learning measures.

Finally, various pieces of research have highlighted the difficulties in generalising the learning acquired with highly-structured procedures, such as the *discrete trial training* approach used in this work. Other *naturalistic* or incidental teaching approaches have proven to be more useful for students with ASD when generalising outside the classroom what they have learnt (see Weiss et al., 2009). Therefore, it seems to be advisable to expand research into the basic self-regulation skills of student with ASD in other learning tasks, with a more functional and contextualised character, inside and outside the classroom.

Notes

[1] The fact that many of these errors are made in the classification phase (and not in the identifying and naming phases), may be because this technique makes it possible to retain and recover concepts consistently. The probability of error in the identifying and naming phases would be greatly reduced, since, at the end of the classification phase, the students were already able to consolidate the verbal labels they had worked on.

References

Artoni, S., Bastiani, L., Buzzi, C. M., Buzzi, M., Curzio, O., Pelagatti, S., & Senette, C. (2017). Technology-enhanced ABA intervention in children with autism: a pilot study. *Universal Access Information Society Journal, 17* (1), 191-210. doi: https://doi.org/10.1007/s10209-017-0536-x

Boekaerts, M. (1999). Self-regulated learning: Where we are today. *International Journal of Educational research, 31* (6), 445-457. doi: https://doi.org/10.1016/S0883-0355(99)00014-2

Burgess, P. W. (1997). Theory and methodology in executive function research. In P. Rabbitt (Ed.), *Methodology of frontal and executive function* (pp. 81-116). East Sussex, UK: Psychology Press Ltd.

Cuskelly, M., Zhang, A., & Gilmore, L. (1998). The importance of self-regulation in young children with Down syndrome. *International Journal of Disability, Development and Education, 45* (3), 331-341.

Delmolino, L., Hansford, A. P., Bamond, M. J., & Fiske, K. E. (2013). The use of instructive feedback for teaching language skills to children with autism. *Research in Autism Spectrum Disorders, 7* (6), 648-661. doi: https://doi.org/10.1016/j.rasd.2013.02.015

Etzel, B. C., & LeBlanc, J. M. (1979). The simplest treatment alternative: The law of parsimony applied to choosing appropriate instructional control and errorless learning procedures for the difficult-to-teach child. *Journal of Autism and Developmental Disorders, 9* (4), 361-382.

Fentress, G. M., & Lerman, D. C. (2012). A comparison of two prompting procedures for teaching basic skills to children with autism. *Research in Autism Spectrum Disorders, 6* (3), 1083-1090. doi: https://doi.org/10.1016/j.rasd.2012.02.006

Kaplan, A. (2008). Clarifying Metacognition, Self-Regulation and Self-Regulated Learning: What's the Purpose? *Educational Psychology Review, 20* (4), 477-488. doi: http://dx.doi.org/10.1007/s10648-008-9087-2

Leaf, J. B., Sheldon, J. B., & Sherman, J. A. (2010). Comparison of simultaneous prompting and no-no prompting in two-choice discrimination learning with children with autism. *Journal of Applied Behavior Analysis, 43* (2), 215-228. doi: http://dx.doi.org/10.1901/jaba.2010.43-215

Lovaas, O. I. (1981). *Teaching developmentally disabled children: The ME book.* Baltimore: University Park Press.

Martín, A., Hernández, J. M., & Ruíz, B. (2007). *Déjame que te hable de los niños y niñas con autismo de tu escuela.* Madrid: Teleno.

Martos-Pérez, J. (2005). La intervención educativa en autismo desde una perspectiva psicológica. *Revista Neurológica, 40* (1), 177-180.

Martos-Pérez, J., & Llorente-Comí, M. (2013). Tratamiento de los trastornos del espectro autista: unión entre la comprensión y la práctica basada en la evidencia. *Revista Neurológica, 57* (1), 185-191.

Mottron, L. (2017). Should we change targets and methods of early intervention in autism, in favor of a strengths-based education? *European child & adolescent psychiatry, 26* (7), 815-825. doi: https://doi.org/10.1007/s00787-017-0955-5

Mulas, F., Ros-Cervera, G., Millá, M. J., Etchepareborda, M. C., Abad, L., & Téllez de Meneses, M. (2010). Modelos de Intervención en niños con autismo. *Revista Neurológica, 50* (3), 77-84.

Ozonoff, S., Strayer, D. L., McMahon, W. M., & Filloux, F. (1994). Executive function abilities in autism and Tourette Syndrome: an information procesing approach. *Journal of Child Psychology and Psychiatry, 35* (6), 1015-1032.

Riviére, A., & Núñez, M. (1996). *La Mirada Mental. Psicología Cognitiva y Educación.* Buenos Aires: Aique.

Russell, J. (2000). *El autismo como tratamiento de la función ejecutiva.* Madrid: Medica Panamericana.

Smith, T. (2001). Discrete Trial Training in the Treatment of Autism. *Focus on Autism and Other Developmental Disabilities, 16* (2), 86-92. doi: https://doi.org/10.1177/108835760101600204

Thomson, K., Martin, G. L., Arnal, L., Fazzio, D., & Yu, Z. T. (2009). Instructing individuals to deliver discrete-trials teaching to children with autism spectrum disorders: A review. *Research in Autism Spectrum Disorders, 3* (3), 590-606. doi: https://doi.org/10.1016/j.rasd.2009.01.00

Touchette, P. E., & Howard, J. (1984). Errorless learning: Reinforcement contingencies and stimulus control transfer in delayed prompting. *Journal of Applied Behavior Analysis, 17,* 175-181. doi: https://doi.org/10.1901/jaba.1984.17-175

Vieillevoye, S., & Nader-Grosbois, N. (2008). Self-Regulation during Pretend Play in Children with Intellectual Disability and in Normally Developing Children. *Research in Developmental Disabilities: A Multidisciplinary Journal, 29* (3), 256-272.

Weiss, J., Fiske, K., & Ferraioli, S. (2009). Treatment of Autism Spectrum Disorders. In J. L. Matson et al. (Eds.), *Treating Childhood Psychopathology and Developmental Disabilities* (pp. 287-332). Routger, N. J.: Springer Science.

Authors' biographies

María Moralo is a Teacher specialised in Special Education and Psychopedagogy. She has a professional experience of more than 10 years in teaching people with autism spectrum disorders at different educational levels, as well as teacher training. She currently works as a teacher of the IES San Roque of Badajoz (first center of Secondary Education in the province in which a specialized classroom has been implemented for this profile of students).

🆔 https://orcid.org/0000-0002-9774-4385

Manuel Montanero has a degree in Pedagogy and Psychology, and a PhD in Pedagogy. He is a Professor of Didactics and School Organization from the Faculty of Education of the Universidad de

Extremadura. His research focuses on the learning of literacy, classroom interaction and educational inclusion, subjects on which he has published more than 60 articles in scientific journals.

iD https://orcid.org/0000-0002-2153-1180

Table of Contents
Sumario

Book reviews