THE USE OF SELF-INSTRUCTION IN THE TEACHING OF COUNTING SKILLS TO PRESCHOOL CHILDREN WITH DOWN SYNDROME

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To: Rachel Lawson

From: Ethical Review Committee

Re: Teaching counting to pre-school Down's Syndrome children utilising self-instruction

The Ethical Review Committee gives approval for the study outlined in your research proposal, and wishes you well.

Steve Hudson

S.M. Hudson
Convenor

cc. Supervisor: Neville Blampied

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Abstract

A multiple-baseline-across subjects design was used to evaluate the utility of a self-instruction programme with five preschool children with Down Syndrome. Parents taught object counting to their children using first an intervention implemented as a comparison (the Macquarie programme), and then following a self-instruction package. A probe was taken for generalisation.

The results found no clear support for the use of self-instruction training in teaching children with Down Syndrome how to count. Some support for interventions providing metacognitive strategies was found after a more in-depth look at the type of error made by these children. Several similarities were found between counting ability of the children in the current study and previous research in this area. Success in the transfer of training setting was mixed following both interventions.

Chapter One

Introduction

First described in 1867 in Down's article "Observations on an Ethnic Classification of Idiots" Down Syndrome[1] accounts for around one third of all children who have an intellectual disability. It is the most common form of naturally occuring mental handicap in developed countries (Wishart & Duffy, 1990; Cicchetti & Beeghly, 1990). This fact plus the ease with which Down Syndrome can be identified at or near birth has made research with these children popular and Down Syndrome may, in fact, be the most investigated of all types of intellectual disability (Hodapp & Zigler, 1990). However, this is not as positive as it may first appear, as Hodapp and Zigler (1990) note:

> " this situation has not necessarily led to a clearer understanding of the behavior of Down Syndrome individuals, however, as a whole range of myths and stereotypes have been advanced (with little empirical support) over the past 100 years... some have begun to receive research attention but the typical behavior of Down Syndrome persons remains far from clear".
> (p. 10)

Before 1970, persons with intellectual disabilities were routinely institutionalised and considered to be ineducable (Thorley & Woods,

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[1] Following the lead of Cicchetti and Beeghly (1990) " Down" has been used rather than "Down's". Cicchetti and Beeghly (1990) support the view held by parents that these children are individuals and should not be viewed as simple extensions of the syndrome.

1979; Nadel, 1988). The prevalent belief was that external factors could not influence development and that the key to development lay in the passage of time (Dmitriev, 1988). As the situation improved for others with mental handicaps with, among other things, the passing (in the USA) of the Education for All Handicapped Children Act (1975), this optimism did not keep pace for those with Down Syndrome (Rynders & Horrobin, 1990). As Rynders and Horrobin (1990) report "Psychology Today" published an article in 1975 that cast doubt on the educability of children with Down Syndrome. Research (Rynders, Spiker & Horrobin, 1978; cited in Rynders & Horrobin, 1990) in response to this article did not provide a strong case for increasing educational expectations. In a literature review of 650 articles they found evidence relating to academic skills was virtually non-existent. The main research focus of the time was the simple measurement of intelligence across a wide variety of age groups (Carr, 1985).

However, in the last decade attitudes and practices have become more enlightened. Children with Down Syndrome reared in enriched home environments and attending intensive Early Intervention programmes are now starting to show their true developmental potential. The last decade has also shown a prolific amount of research reflecting these attitudes. As Nadel (1988) writes:

> "these studies are beginning the much needed job of working out the actual developmental problems faced by children with Down Syndrome when they are reared under the best rather than the worst of conditions". (p. 1)

Down Syndrome: What do we know?

Down Syndrome arises from a chromosomal abnormality. All or part of chromosome 21 appears in triplicate rather than duplicate (Wishart, 1988). Incidence is approximately 1 in 1000 in New Zealand. In 1990 and 1991 there were 53 and 49 births of babies with Down Syndrome (Department of Health, 1992). This is comparable with the United Kingdom (1000 babies) and the United States (7000 babies) (Wishart, 1988). Maternal age is accepted as a factor for determining the risk of having a child with Down Syndrome; the likelihood increases for those women under 20 and particularly for those women over 40 (Hallahan & Kauffman, 1988).

The genetic component in Down Syndrome has a marked effect on intellectual functioning. However, children with Down Syndrome are not a homogenous group as far as intellectual ability is concerned. They range from severely developmentally delayed to close to normal intellectual functioning (Mitchell, 1985; Cichetti & Beeghly, 1990). In comparison to other children with Down Syndrome they may share a "familial resemblance" in intellectual levels with their parents (Hodapp & Zigler, 1990). Development for children with Down Syndrome unfolds at a delayed rate, although they do traverse the various stages of development in the same order as that followed by other children. They have a different structure to their intelligence than mental age matched non-delayed children, performing better on some skills, such as social skills and worse on others, such as language; their development process is considered to be similar to other children in that it is adaptive, organised and meaningful and finally performance deteriorates over time (Hodapp & Zigler, 1990). Poor short-term memory is well documented for children with Down Syndrome and auditory skills are worse than visual skills (Stratford, 1985).

Along with the delay in intellectual functioning, the chromosomal abnormality has an effect on physical development. Delays in maturation, retardation and increased variability have been noted for growth in stature, skeletal maturation and various aspects of dentition (Barden, 1985). A number of health problems are also evident. One in two children are born with a congenital heart defect (Hallidie-Smith, 1985) and problems with hearing and vision are common (Wishart, 1988).

Academic Attainment

Learning to read, write and to use and understand number are the three basic educational skills; gaining a reasonable level of competency at each of these is an integral step along the path of leading a semi-independent existence. Evidence relating to these three skills as well as factors relating to academic success for children with Down Syndrome will be discussed below. Reading, writing and factors relating to academic success will be discussed in brief and numeracy discussed in more depth as this study pertains to this area.

Early Intervention programmes have played a key role in assisting children with Down Syndrome to get a head start on learning these skills. If a child goes to school showing evidence of academic ability expectations of teachers may undergo changes beyond that which their training had led them to believe possible and the child may be less overwhelmed by the new entrants' class (Thorley & Woods, 1979). The first Early Intervention programme was that of Rhodes et al (1969; cited in Buckly, 1985) in a project begun at a state hospital in the United States. In the hospital an intensive language programme was developed which saw the children change from an essentially non-verbal group to gaining basic language and reading skills in a two and a half year period. In New Zealand several Early Intervention programmes emerged in the late 1970s as Straton (1985) describes:

> "...each based upon a well-defined rationale and a careful delineation of the target population, objectives, strategies and service delivery models" (p.125)

Before this little family-centred intervention was available for parents, the predominant view held by professionals was that parents required "relief" from the burden of caring for their child (Straton, 1985).

A number of studies report that representative data on academic attainment are sparse (Sloper, Cunningham, Turner & Krussen, 1990; Carr, 1988; Buckly, 1985). Two reasons are given for this position; firstly, as mentioned above, children with Down Syndrome were routinely institutionalised, in these facilities the emphasis was on care and teaching social skills not academic tasks and secondly it was believed by "experts" that those with Down Syndrome were not capable of learning due to limited academic ability (Buckly, 1985).

Reports from Early Intervention programmes make up the bulk of evidence relating to academic attainment for children with Down Syndrome. Two of the first Intervention programmes to report on their work were the University of Washington project established in 1971 and the Macquarie University programme begun in 1975. At the University of Washington reading was taught to nine 4 and 5-year olds who in a year were able to learn 30 or more flashcards. Ability at writing was not reported (Haydn & Dmitriev, 1975; cited in Buckly, 1985). Of the eleven 3 to 5-year olds at Macquarie University ten had sight vocabularies ranging from 10 to 100 words while the eleventh child was not yet attaching verbal labels to the written words. Eight children (aged from 6 to 9 years) who had been through the programme and were now mainstreamed were reported as having a mean reading age of 7.2 years. Information was also provided on a structured pre-writing programme. It was composed of 15 objectives; teaching skills which ranged from copying a circle (objective 1) to copying words (objective 15). Nine children aged between 3.8 and 5.11 years were reported as mastering between 1 and 14 of the objectives (Buckly, 1985).

However, these two reports have been criticised (Sloper, Cunningham, Turner & Knussen, 1990; Irwin, 1987) as not giving a completely accurate picture of children with Down Syndrome; only reporting on a small achieving percentage of the population. More representative data comes from Buckly and Wood (1983; cited in Buckly, 1985) who report on a group of preschool children, Carr (1988) whose longitudinal study followed a group from six weeks to twenty one years of age, and Irwin (1987) and Rietveld (1989) who discuss the abilities of school age children in New Zealand.

Buckly and Wood (1983) report on 14 preschool children (this sample included all the children with Down Syndrome living at home in two health districts) who ranged in reading ability from matching, selecting and naming pictures to reading simple books. Carr (1988) in a longitudinal study followed 41 persons with Down Syndrome from 6 weeks to 21 years. Two-fifths of the participants could read (mean reading age 7 years 8 months) and the others were able to name varying numbers of letters. Irwin (1987) surveyed a group of 21 Auckland children aged from 9.6 to 11.6 years (nine had been through an Early Intervention programme). Nine could read texts at the 7-10 year level on the Neale Analysis of reading ability, five in the 5 - 6 year old range and seven were not yet reading. Buckly and Wood (1983), Carr (1988) and Irwin (1987) do not report on writing ability.

Rietveld (1989) followed up 22 children (aged 7 to 12 years) who had participated in the Christchurch Early Intervention programme. In reading she reports 18 of the children had a reading age of less than 6 years (Burt word recognition test), one had a reading age of between 6.7-7.1 years and the remaining two were reading at a level close to average for children of their age. Printing was assessed to see if children could trace over words (86% were successful), copy words underneath an example (59% were successful) or from the blackboard (27% were successful) and could print sentences if given help with spelling (32% were successful). The seven pupils who could print sentences were all mainstreamed. However, their printing was characterised by a number of mechanical errors such as letters facing the wrong way, insufficient spacing between letters and words and large and uneven letters. From this evidence Rietveld (1989) suggests that many of these children have not yet obtained the metacognitive skills necessary for learning to print.

Sloper, Cunningham, Turner & Krussen (1990) assessed the reading, writing and number skills of one hundred and seventeen 7 to 14 year old children with Down Syndrome to ascertain the factors related to academic attainment. They found factors that were parallel with those of non-handicapped children. Mental age was the first important factor, followed by environmental factors such as type of school attended. Those mainstreamed did significantly better than those at special schools even after allowing for differences in mental age. Other factors found to be significant were gender- girls did better than boys- and father's locus of control- higher academic attainments were associated with an internal locus of control. In this study, social class was found not to be significant. However, in contrast Buckly and Sack (1990; cited in Sloper et al., 1990) did find educational advantages for children from non-manual backgrounds.

Wishart and Duffy (1990) suggest that motivation is a factor that must be taken into account when looking at the competence in performance of young children with Down Syndrome. They investigated the performance of 18 children with Down Syndrome aged 6 months to 4 years on two commonly used tests of early cognitive development (Bayley scale of infant development and a series of Piagetian object concept tasks). Both tests have been used widely to assess early cognitive development in handicapped children even though neither test is designed for or standardised on handicapped children. The two tasks were presented in the same testing session and repeated 1 to 2 weeks later. They found on average, performance was at approximately half the level that would have been expected given their chronological age. Performances were marked by many failures to engage or a "switching out" response. This was comparable with earlier research by Wishart (1987, 1988a; cited in Wishart & Duffy, 1990) who in longitudinal research with infants and 3-5 year olds with Down Syndrome found that failure to engage was linked to the level of difficulty of the task and the child's stage of development at time of testing. Avoidance tactics were used by these children when asked to do a task one step or more above their current developmental status. Wishart and Duffy (1990) also found instability in performance with items at both the easy and difficult ends of the scale. Only tasks falling within a narrowly defined range of difficulty were fully engaged in and reliably passed.

Numeracy

If data on reading was rare data on arithmetic skills is even rarer (Carr, 1988; Buckly, 1985). The range of skills some children have achieved are mentioned briefly in a number of studies but extensive details are not given (Buckly, 1985). For example, the Washington project only report that the ten children in their group understood number concepts from one to three by age 5 (Hayden & Dmitriev, 1987; cited in Buckly, 1985). In contrast the Macquarie programme's number curriculm has been reported in detail (Thorley & Woods, 1979). Eight children aged from 3.5 years to 5.2 years were taught number skills following a precise curriculum over a period of 23 to 26 weeks. The curriculum included rote counting, enumeration, naming printed numerals and matching sets of up to 10 with printed numerals. Subjects varied in success rate from one who only mastered 1 of the minimal number skills to another who not only mastered all the objectives (38 in total) but other skills such as counting backwards from 10, simple addition and counting to 39. The other six children had mastered between 5 and 30 of the objectives. The eight children of school age who had been through the Macquarie programme and were keeping up with or near their classmates in reading (as mentioned in the above section) were all bottom of the class for number work (Pieterse & Treloar, 1981; cited in Carr, 1988).

This finding is very similar to that of Carr (1988). Her sample of 21 year olds had a mean arithmetic age which was 2.5 years behind their mean reading age. Over one half of the subjects could do no more than recognise numbers and count and only two could do addition, subtraction and multiplication. The highest maths age was 7 years 11 months. However, given the age of these subjects this poor result is not surprising. These subjects would not have had the opportunity to attend an Early intervention programme and would have presumably attended special schools (Carr does not make this clear) where academic achievement is not as great as that for mainstreamed pupils (Sloper et al., 1990). Carr (1988) seems to be aware of the disadvantages her group grew up with and does make the point that these results relate only to this cohort and their contemporaries.

In the area of numeracy, Irwin (1987) found all but one of the children's number skills were poorer that their achievement in reading. As well as a standardised test being administered (Keymath), specific numeracy skills were assessed including rote counting, counting of objects, adding and subtracting and money skills. Of the 21 children (aged between 9.6 and 11.6 year olds) 42% had developed enough number skills to handle numeracy at the mid-kindergarten or 5.5 year level.

Irwin (1987) found not even the most competent of her sample had developed the skill of counting on rather than counting all when adding. In an additional study eight subjects (aged 11 and 12 at time of teaching) were taught to add on. All children acquired the skill and demonstrated it with the generalisation materials and 7 out of 8 children used the add on skills in a follow-up test.

Rietveld's (1989) study of 22 children with Down Syndrome aged 7 to 12 years assessed progress in maths using a number tasks interview. The best of two attempts on each task was recorded. The interview covered 12 number skills items including such things as rote counting, enumeration, money, subtraction, addition and pattern recognition. These were skills of which a typical 7 year old would have had a good understanding. However, from the interview the majority of children with Down Syndrome were only just beginning to develop an understanding of number and could only perform the simplest of the tasks required of them. In enumeration, for example, 64% could count 5 counters in a line but only 23% could count a disordered array of 10 corks and none could count a disordered array of 19 corks. The types of error the children were making were those typical of preschoolers. Very few of the children had mastered addition, subtraction, ordinal numbers and pattern recognition. In a finding which supports Wishart and Duffy (1990), even those number skills which had been acquired were noted to be fragile and unstable. When asked to count as high as possible only 41% of the children managed to produce the same number sequence on both occasions.

One consistently reported finding (Rietveld, 1989; Carr, 1988; Irwin, 1987; Thorley & Woods, 1979) is that number skills seem to be very difficult for these children to master. In reading these children do not appear to be as far behind their peers as they are in numeracy. This may be for a number of reasons but in reality it is probably a combination of all of them (Irwin, 1987). Firstly, the nature of maths itself. Number is an abstract concept and more complex than it may first appear; even the simplest early numeracy programme requires a large number of skills. In counting, for example, a child must remember the number words in the right sequence, objects must be counted only once, each object has only one tag and so on. Yet counting is the most basic process in learning maths so a good understanding is crucial (Zaslavsky, 1979). Secondly, the genetic make-up of these children means they may find it more difficult to process complex and abstract concepts because of factors such as poor short-term memory.

Thirdly, greater attention may be given to literacy than number. Irwin (1987) found that both parents and teachers confirmed that their first priority was that children learned to read. Even if this was not the case, teachers in Irwin's (1987) survey said they did not know how or what to teach these children, so inappropriate teaching and lack of resources may also be a factor. Irwin (1987) found no appropriate resources on how and what to teach these children in the area of numeracy.

In contrast Rietveld (1989) found that parents of children with Down Syndrome were engaged in teaching their children a number of simple numeracy skills, for example, object counting. Even with relevant experience the children still could not master the task. Rietveld (1989) contends practice is not the key; it is the type of instruction which is important. Appropriate instruction would involve teaching the subskills of a task and metacognitive strategies. These are skills which are not obtained incidentally by these children.

In summary, the literature on academic attainment of children with Down Syndrome is patchy, however, it is still compelling evidence to the fact that these children can achieve academically when given the opportunity. As mentioned the genetic make-up of these children must ultimately put some upper limit on intellectual functioning but this limit is unknown. In trying to understand this limit it is important to follow the development pathway taken by these children. The next section will look at counting in this framework; how do children with Down Syndrome learn to count, is it different from other children and if so what are the implications for intervention.

Counting

Children generally enter school with a good understanding of basic mathematical ideas and skills including counting. Most 5 year olds will accurately count up to 20 objects (Baroody, 1987). Even most preschool children know a considerable amount about the sequence of counting and about simple counting principles, especially sets to 5 (Sophian, 1988). As early as 2 years of age some children show evidence of understanding some parts of the number counting process, for example, they use their own reasonably stable list of tags and seem to tag each item with only one number word (Gelman & Gallistal, 1978).

Counting is an involved skill. Gelman and Gallistal (1978) suggest that counting is governed by five principles. Firstly, the one-to-one principle which involves assigning one tick or number word for each item in an array and without which it would be impossible to claim an individual knows how to count. The stable-order principle involves producing the string of number words in a repeatable and stable order. The cardinal principle involves understanding that the last number word has a special significance in that it describes the set as a whole. The abstraction principle deals with the "what to count" and makes the point that any collection of entities (imagined or real) can be counted. The final principle relates to order irrelevance and is the knowledge that number words can be assigned to any item in a group- the order is irrelevant. Counting appears to develop in a hierarchal fashion. Even three year olds have been reported as honouring all five principles (Gelman, 1982; cited in Caycho, Gunn & Siegal, 1991).

Gelman and Gallistal (1978) break the one-to-one principle into two basic component processes. Firstly, partitioning which involves creating two sets of items, those which have been counted and which have not and involves transferring items from one set to another. Tagging, the other part of the process, involves recalling distinct tags one at a time. The two component processes work in step together. From this principle Gelman and Gallistal (1978) list three possible sources of error that can occur in counting; generating an incorrect number word sequence (tagging errors), inaccurately keeping track of which items have been counted and which have not (partitioning errors), and not coordinating the production of the number word sequence and pointing, for example skipping a tag or double tagging an item (coordination errors).

Very young children are prone to make coordination errors in the middle of their counts (Fuson & Mierkiewicz, 1980, cited in Baroody, 1987), coordination errors can also occur at the beginning or the end other counting process (Gelman & Gallistal, 1978). Some children have great difficulty in getting both subskills started at the same time, for example, say one without pointing to the first item, which is then tagged "two".

Counting and children with Intellectual disabilities

Children with intellectual disabilities have difficultity in learning many cognitive skills. However, mastery of number concepts appears to be especially hard for them (McConkey & McEvoy, 1986) Before formal schooling most typical children have acquired a basic counting knowledge. This can not be taken for granted in mentally handicapped children and striking individual differences in ability, even within homogeneous groups of children can be found (Baroody, 1987).

Recent research (cited in Baroody, 1987) indicates that these children are capable of rule-governed as well as rote counting, enumerating sets of objectives, applying the cardinality rule, and abstracting the order-irrelevance principle. For example, McKonkey and McEvoy (1986) tested 51 pupils who were moderately mentally handicapped (mean age =15.3) for numeracy skills. They tested rote counting, recognising numerals and enumeration (both "how many" and "give me"). They found nearly all the students could rote count and recognise numerals up to 10, 50% could accurately and reliably rote count to 20, 37% could count 20 objects when asked "how many" and 41% could "give me" 20 objects. The most common mistakes were a failure to align their verbal counts correctly to their actions (usually their count ran ahead of their pointing to or fetching objects) or else they left out a number word from the sequence.

Baroody (1987) attempts to extend recent research by examining a wide range of counting knowledge for a total of 13 elementary and 23 intermediate children classified as moderately mentally handicapped and 37 elementary and 27 intermediate children were administered structured interviews.

Subjects were tested on oral counting, enumeration and production of objects, cardinality rule, order-irrelevance principle, finger representation 1 to 10 and equivalence. Children classified as moderately mentally handicapped had mastered only four out of ten skills common to typical kindergarten age children. In contrast those classified as mildly mentally handicapped had mastered all but 1 of the ten basic counting competencies. Errors were analysed. In enumeration, for example, though most subjects could count 10 objects a sizeable minority had varying degrees of difficulty, especially with larger sets.

In a similar finding to that of McKonky and McEvoy (1986), the most common error was a complete lack of subskill coordination. These children tended to quickly run through the number word sequence as they glided their finger over a set. Baroody (1987) suggests it is essential to explicitly teach applying one tag to each item and pointing to each item once and only once and for all types of errors and it might be helpful to encourage a child to slow down and count carefully.

Counting and children with Down Syndrome

Two studies (Gelman & Cohen, 1988; Caycho, Gunn & Siegal, 1991) report on the way children with Down Syndrome learn to count and if their counting process is different from that of other children.

Gelman and Cohen (1988) attempted to discover if there were qualitative differences in the way Down Syndrome and "normal" children solve a novel counting problem. Subjects were 10 children with Down Syndrome (mean age = 10.6) attending special schools and 16 four year old and 16 five year old preschoolers. No developmental data was available for the preschool children so they were matched on the basis of their chronological age and SES to the children with Down Syndrome. All children were pre-tested on counting levels and given the same novel counting task which involved counting a five item linear display. The novelty involved making a target item, for example, the middle item number 1 and then counting all the other items. They were then asked to make the target item 2,3,4, or 5. In addition, both groups were given another task to test their flexibility. The children with Down Syndrome were given an 8 item version of the previous task. The additional three items required the children to develop a strategy for remembering which was the targeted one, for example pushing that item out of line. Failure to do this would suggest a lack of flexibility. The preschool children were tested with a five item circular arrangement.

The children were described as being best thought of as subjects in two separate studies that had overlapping conditions. For example, for the children with Down Syndrome a demonstration phase was added to the pre-test after it was noticed that many of the children failed to coordinate pointing with the number word sequence. Also in the novel counting task only the children with Down Syndrome were allowed to be given explicit hints.

From the pre-tests the children were put into groups of excellent counters if they were consistent (two out of three tests correct) in applying the one-to-one and stable order principles. Two of the children with Down Syndrome met this criteria, in contrast to 37.5% of 4 year olds and 62% of 5 year olds. Overall, on the novel counting tasks the excellent counters with Down Syndrome outperformed all the others, followed by the preschoolers and then the other children with Down Syndrome.

From the results Gelman and Cohen (1987) argue their are qualitative differences in the way preschoolers and the majority of children with Down Syndrome solve a novel counting task. They believe that the preschoolers and the two excellent counters with Down Syndrome are able to call on an underlying skeletal set of counting principles to help them solve a novel counting task. This knowledge gives them the ability to self correct false starts, to understand subtle hints and to vary their solution types as the target instruction varied on them, it means they were motivated to stick with a problem until they found a way to solve it and improve as they were given more opportunities to take a trial (they improved as they went from target item as number 1 to the target item as number 3) with no assistance. Only children who have an implicit knowledge of the counting principles can recognise their own mistakes and start over.

In contrast the majority of children with Down Syndrome they believe have developed counting skills by using rote learning procedures. These children did not improve as they took more trials even when given very explicit hints such as detailed instructions or even demonstrations of possible solutions, they were not motivated to stick with a problem and were not able to self-correct error. However, the authors acknowledge that the qualitative differences found are not necessarily related to the genetic make-up of children with Down Syndrome or that these children can be said to totally lacking in the underlying counting principles. They are aware that other variables enter into the equation such as the child's environment and the appropriateness of the teaching received.

As mentioned previously, no developmental data was available for the preschool children in this research. Caycho, Gunn and Siegal (1991) suggest that a possible limitation with Gelman and Cohen's (1988) research was their matching based on chronological age and SES. Caycho et al., (1991) believe that developmental level rather than Down Syndrome would determine counting knowledge.

Caycho et al., (1991) compared 15 children with Down Syndrome (mean age = 9.7 years) and 15 preschoolers (mean age = 4.6 years) to find whether those children having a similar developmental level (mean age equivalent score on the PPV-T was 4.7 years) have an implicit and explicit understanding of number.

To reduce any problems in communication and to clarify the task a puppet was used to count items. The children were asked if the puppet's counting was correct or incorrect. The children were also asked to count a 5 and 8 item array and then perform Gelman and Cohen's (1988) novel counting task on a 5 item array. Their were no significant differences found between the preschoolers and the children with Down Syndrome; competence on most of the counting tasks was related to receptive language age. The majority of children with Down Syndrome appeared to show an implicit understanding of the one-to-one and stable order principles and of the how many level of knowledge concerning cardinality. In a finding similar to that of Gelman and Cohen (1988) the children with Down Syndrome showed a wide range of abilities.

A number of studies that have discussed numeracy and children with Down Syndrome (Caycho et al, 1991; Rietveld, 1989; Gelman & Cohen, 1988) question the appropriateness of what Gelman and Cohen (1988) describe as "drilling children in the count and word sequence". (p. 94) They believe a cognitively oriented programme in which metacognitive skills are taught would aid these children to develop an implicit and explicit understanding of number. Caycho et al. (1991) write that their subjects who showed knowledge of an underlying skeletal sets of number principles:

> "...may be more typical of children who have had some exposure to a program that involves more than rote training procedures (e.g. one in which the child is helped to master the partitioning of items in an array and to coordinate the verbal counting with pointing)" (p. 582)

In support of this view is research (Meichenbaum, 1980; Borkowski, Reid & Kurtz, 1984; Whitman, 1987; Lauth & Wieldl, 1989) which indicates that intellectually handicapped children lack metacognitive skills. This is also true for those classified as learning disabled and the majority of research on metacognition has focused on this group (Wong, 1985). However, this review, for obvious reasons will concentrate on those who are mentally retarded. The research giving more detail of the metacognive deficits in persons who are mentally retarded will be discussed as will the view held by Rietveld (1990) that metacognitive deficits can account for the low academic achievement of children with Down Syndrome.

"Metacognition" refers to one's knowledge about cognitions. It is the executive decision making process in which a person addresses his or her own thinking; both carrying out cognitive operations and overseeing their own progress (Meichenbaum, 1980; Loper, 1980). In the case of retarded children Borkowski et al., (1984) believe these children may have the strategy for a task in their schema but simply lack the knowledge regarding when, how and why the strategy might be applied. Lauth and Wiedl (1989) agree with this view but add on an additional number of determinents of cognitive retardation in an approach based on the analysis of learning behaviors of retarded children with the help of theories of cognitive and action regulation. Their determinants of cognitive retardation are: deficits of higher level behavior strategies, for example, problem solving skills; inadequate metacognitive mediation of behavior which is relevant for learning, for example, unable to see and correct error; restricted development of basic skills; deficient knowledge about the respective behavior objectives; motivational impairment and poor ability to generalise due to a lack of rules and deficient metacognitive mediation of behavior. Although this theory is mainly proposed by Lauth and Wiedl (1989) research, some already discussed would support most of these proposals. For example, Wishart and Duffy (1990) discuss motivational impairment and Wong (1986) suggests metacognition provides insight into the failure of persons with intellectual disabilities to maintain and generalise learned strategies.

Poor generalisation ability has also been noted for children with Down Syndrome (Stratford, 1985). Poor stategy generalization and widespread evidence of production deficiences and an inability to solve these problems by traditional approaches are the reasons Borkowski et al. (1984) gives for the investigation of metacognition.

In a comprehensive discussion of the literature Rietveld (1990) examines metacogntion and factors influencing the development of metacognitive strategies in normal low and high achieving children and the implication of that research for children with Down Syndrome. Low and high achieving children differ in their application of strategies. Low achieving children have been observed to use low level strategies; these are that they are less likely to select and process information to fit the requirements of the current task; they have a poor schema for the task and they do not take into account the whole task only specific details and show little awareness of errors (Cullen & Carver, 1982; cited in Rietveld, 1990). Children with Down Syndrome have been observed to use low level strategies (Rietveld, 1988; cited in Rietveld, 1990).

Rietveld (1990) argues that for children with Down Syndrome, obtaining schemata for a task and the acquisition of metacognitive skills is compounded by other information processing difficulties, such as poor short term memory and visual perception of only isolated stimuli. Poor short term memory must make any academic learning which involves following instruction harder. Instruction given orally may be forgotten and the appropriate strategy to ask for a repeat of the instruction may not be available to these children.

Visual perception of only single aspects of an image has been established as early as six months for infants with Down Syndrome. They also show a distinct preference for simple stimuli and avoid complex patterns (Stratford, 1985). Successful performance on an academic tasks requires attention to several features simultaneously and so these children find acquiring appropriate strategies and schema for a task much more difficult.

The issue of low achievement, Rietveld (1990) argues, is made more difficult when motivational impairment is added. This factor must be taken into account along with poor short term memory, lack of schemata for the task or other unidentified reasons in causing instability in performance.

One method of acquiring metacognitive knowledge is through self-instruction. Self-instruction is a process of providing one's own verbal prompts. Research has suggested that self-instruction is useful in that it encourages active monitoring of one's thought process, reduces the passive nature of the learner and facilitates the maintenance and generalisation of strategy use (Whitman, 1987). Self-instruction grew out of the work of Luria (1961) and Vygotsky (1978) and their research on the role of speech development and motor behavior control (Finch & Spirito, 1980). One of the first researchers to apply a self-instruction training paradigm explicitly to the solution of clinical problems were Meichenbaum and Goodman (1971, cited in Bryant & Budd, 1982). Their work was on impulsive school children and they used self-instruction as a means of improving their performance on academic tasks.

Self-instruction training involves teaching the child specific verbalisations that follow a step by step process. These verbalisation's are related to the difficulty faced by the child, they are modelled by the therapist and then rehearsed by the child. The verbalisation's are of 4 types (1) problem definition (What should I do in this situation) (2) focusing of attention (3) coping statements and self-reinforcement (Finch & Spirito, 1980).

The self-instruction literature is vast. Self-instruction training has been used to increase general behaviors required for academic success such as pupil attention to task, as well as to develop specific academic skills such as maths, writing, and reading comprehension (Whitman, 1987). Self -instruction, it has been suggested, is not equally successful with all children. Whitman (1987) believes that to be effective, a self-instruction programme must take into account the developmental status of the person involved. He argues that self-instruction will be beneficial to those who have a limited language and knowledge base, for example, young children and individuals who are mentally retarded. This view is based on several assumptions:

(a) Those with limited language skills may have difficulty in processing and using instruction and using words to cue their behavior. Self-instruction can supply words, help comprehend the meaning of words and uses words to guide and regulate action.

(b) Those with a limited knowledge base need to get more information in order to perform well on the task. Verbalising what must be done assists in processing that information.

(c) Complex tasks are difficult for those who posses a poor schema for the task and lack the strategic ability to assist themselves. Self-instruction can provide a knowledge base and problem solving skills for completing a task successfully. (p. 217).

In light of Whitmans argument this last section will look at the empirical evidence relating to self-instruction in those who are mentally retarded and in preschoolers.

Self-Instruction and Mental Retardation

Whitman (1987) writes:

> "Retarded persons should derive special benefits from self-instruction training because of its emphasise on teaching productions of relevant verbal cues and use of these cues as an attention focusing device, a vehicle for processing information, and a means of regulating motor behavior. If this assumption is correct, retarded persons should show better attention, memory, and motivation as well as manifest less impulsive behavior, less maladaptive perseveration and less field dependency".
> (p. 221)

A number of studies have shown that self-instruction can be taught and is useful for persons who are mentally retarded. For example, in on-task behavior, Bugio, Whitman and Johnson (1980) report on two mentally retarded children (one 9 and one 11) and three control subjects. During training, the experimental subjects were taught through self-instruction to focus their attention on two academic tasks, maths and printing. When exposed to distracting situations, those taught self-instruction still improved the amount of time they managed to stay on task. This transferred to a classroom setting. No improvement in academic performance was found. This the authors suggest would require a specific self-instruction programme catering to academic performance.

Self-instruction has proved useful in improving performance on academic tasks, for example, Murphy, Bates and Anderson (1984) studied nine preschool handicapped children (mean age = 5.3 years) who were taught how to use self-instruction in counting requested numbers of objects from one to ten. The results showed that eight out of nine students showed an improvement in counting accuracy. These gains generalised to functional objects and were maintained at a six- month follow-up session.

Whitman and Johnson (1983) examined the effectiveness of a self-instructional training program for teaching math computational skills to nine children who were mentally retarded (mean age = 11 years 10 months). It was based on an earlier study by Johnson et al. (1980) which examined the efficacy of a self-instructional program designed to improve academic performance, specifically the addition and subtraction with regrouping skills of three children from a special education classroom. The results indicated that a self-instructional package implemented in a group setting can be effectively employed for teaching addition and subtraction regrouping algorithms to children who were mentally retarded.

Keogh, Whitman and Maxwell (1988) examined whether self-instruction is more effective for children who are mentally retarded than an external instruction programme and if these children will benefit more from self-instruction than children of normal intelligence. Subjects were 38 first graders (mean age = 7.3 years, CA = 7.2) and mildly mentally retarded children (mean age = 10.6, CA = 6.6). They found that the children who were mentally retarded performed more accurately under the self-instruction than under the external instruction whereas the other children performed similarly under the two instructional conditions. This result tends to support Whitman's (1987) contention that this type of programme is very much suited to the needs of retarded children.

In contrast Borkowski and Varnhagen (1984) found no difference between a traditional programme and one using self-instruction. They taught anticipation and paraphrase strategies embedded in either a self-instruction or a traditional didatic format to 12 children who were mentally retarded with 6 children as a control and they found excellent maintenance of complex learning strategy by the children with mental retardation. Self-instruction training neither facilitated the maintenance of either strategy nor resulted in greater recall than traditional strategy training. On the final generalisation test, however, significant improvement in recall accuracy was noted for both format conditions and two of the six in the self-instruction group did report use of the most complex strategy. This was not reported by any subjects in the other group. Both experimental groups out-performed the control group. Borkowski and Varnhagen (1984) write " it appears that the potential effectiveness of any self-instruction package is difficult to predict" (p.377). Obviously, further research is required. This is also the case with Whitman's assertion that linguistic ability will predict self-instruction performance since Keogh et al. (1988) found this not to be the case, and neither did Spence and Whitman (1990).

Spence and Whitman (1990) undertook research to examine Whitman (1987) contention that mentally retarded individuals will benefit more from self-instruction than external instruction procedures because of their language difficulty. Forty-four individuals in a vocational training centre severed as subjects (mean age = 31. 8 years). All could speak in intelligible sentences of two words or more. Two sorting tasks were taught using self-instruction. No performance differences were found between the external and self-instruction procedures, nor evidence that trainees with lower linguistic ability benefited more from self-instruction training. The authors suggest future research needs to compare the efficiency of self versus external instruction training formats with subjects with a greater range of verbal ability. Self-instruction may be beneficial to those with more or less verbal ability than those in this study. Also the task was not very verbal, so in this study it may have been performance ability not verbal ability which best predicted performance.

Self-Instruction and Preschoolers

Preschoolers have only rarely been studied in the self-instruction literature (Bryant & Budd, 1982). However, a few studies (Brown, Meyers & Cohen, 1984; Bryant & Budd, 1982; Bornstein & Quevillion, 1976) have taken up the challenge of extending the age range who can benefit from this approach and have introduced it to preschoolers. As Bryant & Budd (1982) state:

> "Preschoolers would seem to be an optimal population for the study of self-instruction, considering they are verbal and yet have a relatively short history (if any) of verbal control over nonverbal actions (cf. Luria, 1961) and may be more likely than older children to self instruct overtly." (p.261)

Researchers made adjustments for the children's age such as using a visual stimulus, only rehearsing at an overt rather than covert level (Brown, Meyers & Cohen, 1984), use of naturalistic tasks (relevant to their future academic environment) (Brown et al., 1984; Bryant & Budd, 1982) and training limited to ten minute sessions a day (Bryant & Budd, 1982).

Early research (Mischel & Patterson, 1975, 1976; cited in Pressley, 1979) on preschoolers studied resistance to temptation tasks. They found that even preschoolers can use a verbal strategy to control their own behavior in a situation where children often "misbehave". However, the preschoolers could not generate their own controlling verbalisation's.

Robin et al., (1975) taught 30 children (mean age = 5.5 years) with writing deficiencies how to print. There were three groups; children were taught using either self-instruction; direct training or a no treatment control group which was included to assess the role of reinforcement practice. Self-instruction proved superior to direct training while both treatments proved superior to no treatment. A generalisation test revealed no difference between any of the groups. Although the self-instruction was successful in improving printing, Robin et al. (1975) describe the approach as impractical and cumbersome.

Schleser, Meyers and Cohen (1981) criticised Robin et al., (1975) for the narrow focus of their instructional package, and suggest this was the reason for their lack of generalisation. They took 70 pre-operational and 70 concrete operational (developmental level was based on their performance on two conservation tasks) first and second graders and gave them the matching familiar figures test and a general measure prior to and after serving in one of five instructional groups. The instructional groups were a no-training control group, a specific self-instruction group, a specific didactic control group, a general self-instruction group, and a general didactic control group. Overall, the children receiving instruction specific to the training task experienced the greatest benefit of all the groups on the training task experience. However, only those children receiving the generalised self-instruction content improved significantly on the generalisation task. They suggest this shows the importance of active involvement. Children in the didactic control group did not experience gain from instruction while those in the self-instruction groups did.

Bornstein and Quevillion (1976) investigated the effects of a self-instruction package on three overactive preschool boys (mean age = 4 years). All increased on- task behavior, demonstrated transfer of training effects from the experimental task to their classroom, and treatment gains were maintained over 22.5 weeks.

Brown, Meyers and Cohen (1984) assigned 27 4 and 5 year olds to one of three instruction groups: a self-instruction group, a skills-training group and a no- treatment control group. Each group was trained on a "same and different" task, a series of mazes, and a size sequencing task. Only the self-instruction group improved on the novel tasks. Brown et al. (1984) suggests that as well as facilitating the application of specific, previously trained problem solving skills, self-instruction provides the child with an effective self-controlled problem solving strategy that guides performance in both familiar and novel problem solving situations.

In a similar study Bryant and Budd (1982) studied three "impulsive " preschool children aged 4 and 5 years. These children demonstrated poor independent work performance. This work examined aspects of self-instruction to academic behavior of children in every day classroom activity. The children completed worksheets focusing on three skills: finding the same, mazes and size sequencing. For all three children, self-instruction training resulted in an increased level of accuracy on worksheets. They also found that rates of on task behavior may have improved and that a mild classroom intervention further strengthened on- task rates and effected consistent work completion for all three children.

Rationale for the current study

Summary

Recent evidence has suggested that children with Down Syndrome are capable of achieving academically. This was something not thought possible only a short time ago. However, these children have only recently been given the opportunity to achieve through de-institutionalisation and Early Intervention programmes, so what is known is very limited. As Nadel states:

> "...we are quite ignorant of many of the most basic facts about Down Syndrome. We do not know what the cognitive and functional limits are, how these limits change during the lifespan, and what kinds of interventions can help reach or perhaps even expand these limits." (p. 1)

In the general area of mental retardation a number of determinants of cognitive retardation have been suggested. These include well documented aspects such as an inability to generalise and production deficiencies across a wide range of learning tasks. More recently it has been suggested that a lack of metacognitive skills is also indicated. Rietveld (1990) argues that this is true for children with Down Syndrome. Evidence she has collected suggest these children are using low level strategies and that repeated practice of a task does not seem to be the key to success for these children. For instance, Rietveld (1989) found that parents gave their children plenty of opportunity to count objects, yet when tested the children where not very competent at this skill. This view is supported by Caycho et al. (1991) whose research on counting suggested that those who had obtained the underlying counting principles had access to a programme which taught more than rote counting skills.

A type of intervention which provides metacognitive skills is self-instruction. Whitman (1987) argues this intervention is particularly suited to persons with mental retardation and young children based on their limited language and knowledge base. Self-instruction is useful in that it supplies words and knowledge and the words can be used to guide and regulate action. On the whole empirical evidence supports the utility of this procedure with preschoolers and those who are mentally retarded, but a number of points are still at issue and require further investigation, e.g. , the linguistic level that is best suited to self-instruction and a self-instruction package that is relaible with a wide variety of groups and tasks.

The Current Study

The aim of the present study was to evaluate the utility of a self-instruction programme with a group of preschool children with Down Syndrome. Learning of the programme would encourage these children to develop a meaningful and stable schemata for counting and therefore one which would enable generalisation to occur.

The self-instruction programme followed the steps proposed by Meichenbaum (1977), with adjustments for the age of the children. The Macquarie programme, an intervention already proven with children with Down Syndrome, was used as a comparison. The task chosen to be taught was counting as it is forms the basis for learning maths and is considered more difficult for these children to learn than other academic skills.

This study had as its aim two further issues suggested by the literature:

- to continue to document evidence of the academic ability of children with Down Syndrome particularly in the area of numeracy

- to provide support for metacognitive interventions with children with Down Syndrome.

Chapter Two

METHOD

Subjects

Subjects were 5 children (4 boys and 1 girl) with Down Syndrome. All children were confirmed as Trisomy 21 Down Syndrome. They ranged in age from 4 years 4 months to 5 years 9 months (mean age = 4 years 9 months). Four subjects were attending the Christchurch Early Intervention clinic. After attending the clinic for 5 years, the fifth subject had recently moved into a mainstreamed school setting. Written permission was obtained from their parents for the children to take part in the study. The Downs Syndrome Performance Inventory (Hayden & Dmitriev, 1971) was used to gauge the age group of the children's skill level. Age group levels were provided in the following areas: fine motor, cognitive and language. This information was routinely updated by therapists at Early Intervention. Social, self-help and gross motor scores were not included as this information had not been collected for some of the subjects. Permission was obtained from parents to use the information from the performance inventory.

Table 1. Age (in years and months) of child at time of study, age from which child has attended Early Intervention and level of functioning of children in this study

				Performance Level		
Subject	Gender	Age	Age began E I	Fine Motor	Cognitive	Language
1	F	4.5	0	3 to 4	3 to 4	2 to 3
2	m	5.9	11	3 to 4	3 to 4	2 to 3
3	m	5.3	0	4 to 5	4 to 5	4 to 5
4	m	4.4	0	4 to 5	4 to 5	3 to 4
5	m	4.11	0	5 to 6	4 to 5	3 to 4

NB:- M=male, F=female, EI =Early intervention

The subjects were selected from a total pool of nine, 4-5 year old children with Down Syndrome attending an Early Intervention setting. The other four children were not considered for various reasons: Two parents initially accepted then withdrew their children for personal reasons, one child had continual health problems and the other was not available at the time parents were approached.

Parents

The socio-economic level of the families is summarised in Table 2. All the women in the study were full-time wives and mothers. Their rating is based on premarital occupation. The socio-economic levels were derived by applying the Elley and Irving (1985) socio-economic index (revised) to the father's occupation and their Female labour force index (1977) to the mother's occupation.

Table 2. Parent's socio- economic status

Subject	Father	Mother
1	3	6
2	4	6
3	3	-
4	3	4
5	1	3

Setting and Materials

Training was done in the subjects' homes and in all cases the dining room was selected as the training area. This was the normal homework room. Objects used for counting were chosen by parents. These were objects the children were familiar with and enjoyed counting, for example plastic people, cups, tiny teddy biscuits and cars. A variety of objects were employed during each session. This was to assist in generalisation and to help to maintain the child's interest. Each session was audio taped. All tapes were provided, as were tape recorders where needed. Stickers and a recording chart were available for use after each session. A set of written instructions (see Appendix A) was used at each stage.

Rating procedure and Reliability check

The overall accuracy of the counting was assessed. A further analysis was done to find the type of error the child was making. All sessions were audio taped and a second rater randomly selected one session in the baseline and three in the two other phases to listen to. Counting correctly was defined thus: The child had to begin at the appropriate end and start with one before counting was said to have begun. The child's level of self-instruction was also rated. In order to be scored as an agreement a verbalisation had to be one word or more relevant to the step the child was taking. Each verbalisation was further classified by the type of prompt that was applied. Categories are shown in Table 3.

Table 3. Level of prompt applied

Level	Prompt
0	Independent performance
1	Non-specific
2	Specific verbal
3	Modelling

Parents' adherence to teaching the self-instruction programme was also recorded.

At the conclusion of the research a questionnaire (see Appendix B) was sent to parents. It asked five open ended questions to elicit parental satisfaction with the intervention. The questions asked how difficult each programme was to implement, if the they liked or did not like any aspect of the programmes and if they felt their child's counting had improved.

Design

A multiple-baseline-across-subjects design was used to analyse the effects of two procedures on counting. Following a baseline period, the Macquarie programme was introduced as the first intervention. The Macquarie programme was designed in order to teach a group of preschool children with Down Syndrome a set of minimal number skills (Thorley and Woods, 1979). It was chosen as a comparison to the self-instruction programme for a number of reasons: It was designed specifically for children with Down Syndrome, it was proven as a useful teaching tool and parents were familiar with it. After the subjects reached a certain reference criteria the self-instruction programme was initiated as a second intervention.

Procedure

Pre-testing

Initially each child was tested on their ability to point to an object. This was a skill required in the two training programmes. A speech therapist at Early Intervention checked the suitability of the language in the self-instruction programme. Changes were made following her suggestions.

Baseline

Baseline measures of counting were taken until a non-accelerating trend was obtained. Baseline data were collected in the home. Parents placed a number of items in a row. The child was given the verbal cue "Count the _____, (child's name)". No feedback was given regardless of a correct response. Subject 1 received 1 baseline check; subject 2 two baseline checks; subject 3 three baseline checks; subject 4 four baseline checks and subject 5 five baseline checks.

The Macquarie programme

The Macquarie programme was introduced after the baseline sessions. A written instruction sheet was provided to each parent. Teaching sessions were required to be between 5-10 minutes long. Parents were required to tape each session. All children were reinforced with social praise. In addition, Subject 2 was reinforced with a sticker on the completion of each session. These sessions were continued until the children learnt two numbers or a month had elapsed. A child was deemed to have learnt two numbers using the Macquarie criterion. This required two out of three trials correct for three days. The number of sessions in the phase varied from 11 to 25.

Self-Instruction programme

Three steps were adapted from Meichenbaum's (1977) self-instruction programme to form the training procedure. These were:

Step 1. The parent modeled the task while verbalising the self-instruction steps aloud while the child observed.

Step 2. The child did the actions while the parent instructed aloud, that is to say, the child pointed and counted.

Step 3. The child performed the tasks while overtly self-instructing, with occasional prompts from the parent.

In Meichenbaum's (1977) programme, a fourth and fifth step, where the child would guide her performance by whispers and then by private speech would be introduced. These steps were left out as it was decided they would be too difficult a task for these children. This also meant, if overt self-instruction transfered to a different setting that it could be heard and recorded. Bryant and Budd (1982) had preschool children as subjects, they chose, due to the age of the children to hold training sessions for only ten minutes. This was in contrast to the 20 minutes to 2 hours sessions held in other research. The shorter sessions were considered more appropriate for the children in the present study.

The parents were asked to perform the self-instruction programme three times during each session. To begin each session the parent obtained the child's attention in the following way:

_(Name)__, I want you to listen and look at what I am going to do. Are you ready?

This was followed with the self-instruction steps. They were:

Ok, What is it I have to do? I have to count the ________
I have to start at this end and go slowly.
I must point to the first ___. This is 1.
I must go slowly then point to the next ___. This is 2.
I must point to the next ___. This is 3.
I must go slowly then point to the next ___. This is 4.
I must point to the next ___. This is 5.
This is the last ____ and so I stop counting.
_______, did good work.

All steps had a minimum of two sessions. Step 1, in all cases, was performed for the minimum number of sessions. Steps 2 and 3 were performed for a larger number of sessions.

Additional instructions were added for steps 2 and 3. In step 2, the child was reinforced for counting correctly. Instructions were provided on what to do if the child made a mistake. In step 3 the self-instruction programme was further broken down to aid learning. The child was taught the first line and then the parents would return to following step 2. In the next session the child would give an approximation to the first line and be taught the second line and then the parents would return to the instructions from step 2 and so on. Reinforcements were given for approximations to the self-instructions. All parents chose to use social reinforcers. In addition, Subject 1 was reinforced with dried apricots.

For the first session, Subject 5 followed the above procedure. However, it was decided, after consultation with his mother, that the following programme was more suitable to his needs. This was:

Ok, What is it I have to do? I have to count the ________
I have to start at this end and go slowly.

I must point to the first ___. This is 1.

2.3.4.5

I must go slowly....6

7,8,9,10,11,12,13,14.
This is the last car and so I stop counting.
_______, did good work.

This second programme took into account the greater range of numbers Subject 5 was counting as compared to the other children. It was felt that following the original programme, too much verbalisation was required to reach 14. If the child reached a point where he/she could consistently self-instruct with specific prompting, non-specific prompting was introduced. Finally parents were asked to get a measure of their child's counting over 3 days

Parent Training and Participation

The parents through their participation in Early Intervention already acted as academic teachers of their children. The Early Intervention programme was described as:

> " a group of parents and professional staff who work closely together to support and skill parents to provide an individual development programme carried out primarily by the parents within the context of their family/ whanau. "
>
> (Early Intervention brochure)

This philosophy meant that parents were aware of such behaviour change techniques as shaping, prompting and modelling. Parents were asked in the training phases to spend 5-10 minutes a day teaching for as many days a week as they could manage. Time spent teaching counting was simply added to time normally spent on homework from Early Intervention.

Three mothers acted as trainers in all phases of the study. The father of Subject 3 took 2 baseline sessions, and all other sessions were taken by his mother . In the case of Subject 4 the responsibility was shared equally between parents. In baseline, parents were provided with a written set of instructions and a verbal explanation of these was provided during a home visit.

Parent training for the Macquarie programme consisted of :

A) A written set of instructions

B) Re-familiarising parents with terms such as modelling, shaping and prompting

C) A home visit where the technique was modelled and parents were observed teaching their child

D) Regular phone calls from the researcher.

For the self-instruction programme parent training consisted of:

A) A general overview of the procedure

B) Written instructions

C) Step 1 and 2 explained in a 15 minute home visit

D) Two further home visit to explain step 3 and non-specific prompting. Modelling of the procedures.

E) Regular phone calls or, if necessary, home visits.

F) Parents were provided with feedback on their performance and corrective suggestions offered as necessary.

Transfer of Training

Transfer of training was assessed in two different ways: across settings and across trainers. Three probes were taken for each child. These were taken following baseline, the Macquarie programme and the self-instruction programme. For three subjects transfer was assessed at Early Intervention. The cognitive therapist acted as the trainer at Early Intervention. Counting was assessed as part of her normal session with each child. Subject 5 was assessed at Early Intervention after baseline and the Macquarie programme.

However, near the completion of the self-instruction phase he moved into a mainstreamed school setting, where he was assessed by counting other children in his classroom. For Subject 4 assessment occured at his school during all phases of the research. His teacher aide asked him to count. All sessions were audiotaped.

Chapter Three

RESULTS

Reliability

Using the formula

$$\text{Reliability (percent)} = \frac{\text{number of agreements}}{\text{no. of agreements + no. of disagreements}} \times 100$$

interrater agreement levels were 86% or above for each phase. The mean interrater agreements across the phases were as follows: baseline 100%; Macquarie programme 93%; self-instruction training 86% and questionnaire comment's 94%.

Counting response

The number of items subjects counted correctly during the study is shown in Figure 1. These points represent only the first attempt at counting within a session. The decision to include only the first point was made as this was considered a true attempt at counting unaided by parent assistance or memory of the previous count.

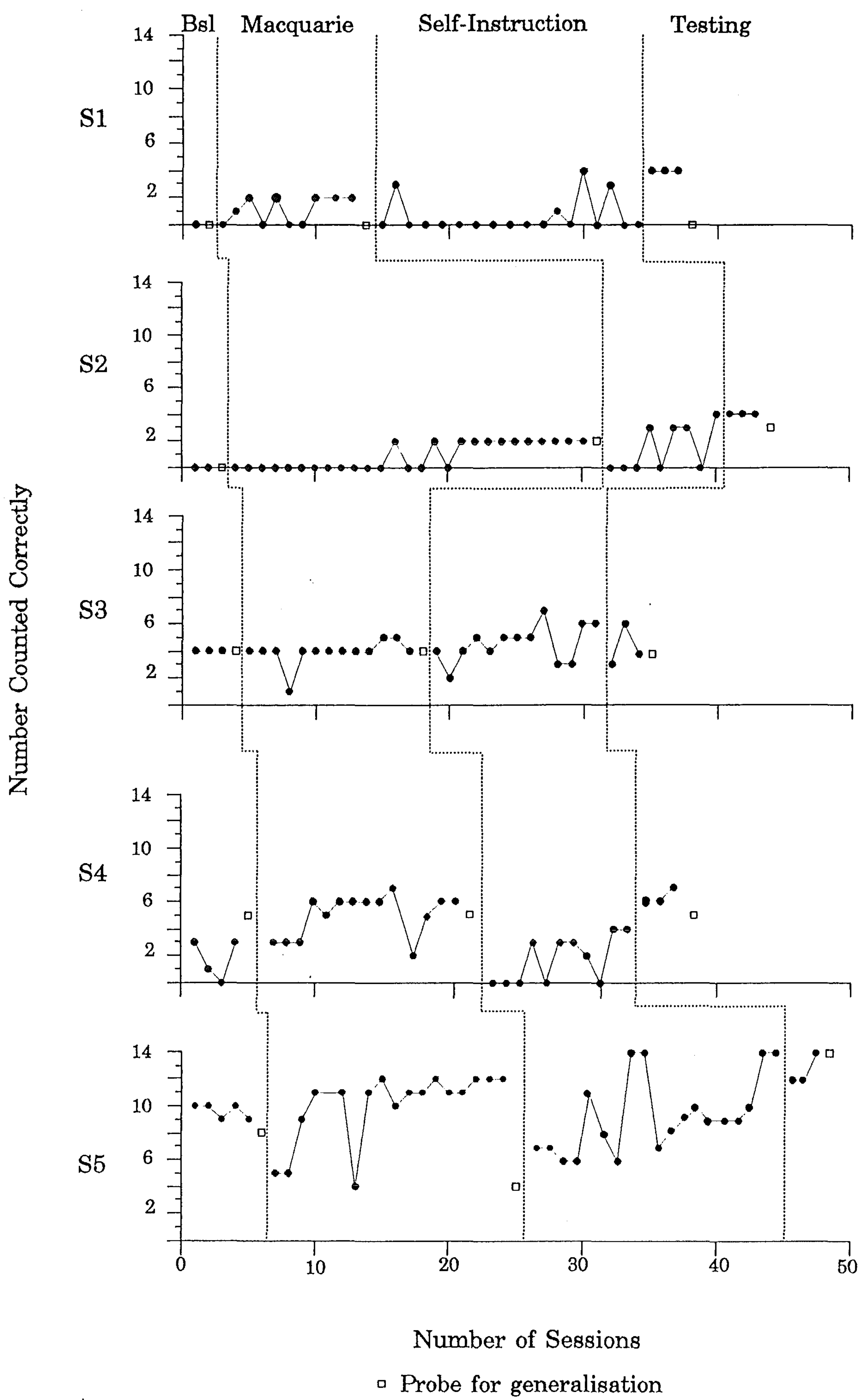


Figure 1: Number of correct counting responses performed by 5 subjects in Baseline (no Intervention), under the Macquarie and Self-instruction interventions and in a testing phase.

Baseline

During baseline Subjects 1 and 2 counted no items correctly and Subject 3 across three trails consistently counted to 4. The same result was recorded for these subjects in the transfer of training setting. Subject 4, was the most inconsistent. His counting ranged from 0 to 3 in the home setting. A high count of 5 was recorded at Early Intervention. Subject 5 recorded the highest count of all subjects during baseline, reaching 10 on 3 occasions and recording 9 on the other two. At Early Intervention he counted to 8.

From baseline data, it was decided that during phase 2 Subjects 1 and 2 should be taught to count to 2, Subject 3 to 6 and Subject 5 to 12. Although subject 4 only counted to 3 during baseline, written notes from Early Intervention confirmed he was able to count to 5. Also his parents noted his reluctance to count with the tape recorder present. From this information, Subject 4 was asked to count to 7.

Phase 2 -The Macquarie programme

The introduction of the Macquarie programme saw four of the Subjects improve by counting at least one more number. Subjects 1, 2 and 5 were able to meet the criterion of two numbers. Subject 1 took 7 sessions and Subject 2 took 17 sessions to consistently reach their target. Subject 2 remained at nought for 12 sessions. He then fluctuated between 0 and 2 before levelling out at 2. A similar pattern was observed for Subject 1 who also fluctuated between 0 and 2 before consistently reaching two.

Subject 5 took 14 sessions to reach his target. He continued to be very variable in his counting. The items counted correctly ranged from 4 to 12. Counts 10 and below were recorded on 5 occasions; 11 was recorded on 7 occasions and the number 12 on 2 occasions.

During the six- week intervention period, Subject 4 improved by one number and Subject 3 improved very little. Subject 4 took 12 sessions to learn to count another item. Subject 3 was very consistent, recording 4 on 9 out of 10 occasions. During the other session he counted 1 item correctly. On only 2 occasions did he improve to count 5 items. Subject 4 showed variability in his counting; the items counted correctly ranging from 3 to 7. Counts of 3 and below were recorded on 4 occasions; 6 items were counted correctly on seven occasions; 5 items were counted correctly on two and only once did he count the full 7 items.

In the transfer of training, setting subjects 1,3 and 4 showed no improvement from baseline. Subject 5 counted 4 items before making an error and Subject 2 improved to count 2 items.

Phase 3 - Self-instruction training

During the self-instruction training phase all subjects showed a great deal of inconsistency. By the end of the training Subjects 1 and 2 showed improvement in counting. In the testing phase they consistently reached their target of 4. Subject 1 took 18 sessions (10, no count) and Subject 2 took 9 sessions (5, no count) to reach this point. However, it must be noted that neither subject mastered any form of independent self-instruction during the training.

Subject 5 showed improvement in counting. However, during acquisition of the self-instruction, or the first 10 sessions, his counting showed a great deal of variability ranging from 5 to 14. From the 11th session onwards a more consistent and slowly improving trend began to emerge. He reached his target and was able to maintain it in a transfer of training setting. In the testing phase he recorded 11 twice and 14 once.

Subjects 3 and 4 were inconsistent in their count. Subject 3 started to show an improvement counting to 5 on 4 occasions, 6 on two occasions and 7 on 1 occasion. He maintained his phase 2 level of 4 on three occasions. On 3 occasions he dropped below 4. In the testing phase this inconsistent trend continued, counts of 3, 4 and 6 were recorded. Subject 4 showed a decrease in counting in the self-instruction acquisition phase, returning to baseline levels. He counted 0 on 4 occasions, 2 on 1 occasions, 3 on 3 occasions and 4 twice. However, in the testing phase he was able to count more items. He recorded 6 twice and 7 once.

In the transfer of training setting Subjects 1,3 and 4 showed no improvement and Subject 2 and 5 improved their performance.

Types of Error

The types of error the children were making were analysed across each intervention phase. Each attempt at counting within a session was evaluated. This is shown graphically in Figures 2a-e. The errors form two types; sequencing (displayed with a black bar) and coordination (displayed with a striped bar). The sequencing errors were put into a group and displayed according to where the error was made in the sequence. The type of coordination errors, for example, double tagging an item, are also displayed individually.

Overall, there were a wide variety of errors. The major error involved producing the wrong number word sequence. Other errors included no counting and pointing incorrectly, therefore counting an item twice or skipping one. Two out of five subjects made no coordination errors and one decreased his from 34% in the Macquarie phase to 6% with the introduction of the self-instruction programme.

Subjects 1 and 2 made similar errors in both intervention phases. In the Macquarie phase Subject 1 offered no count one quarter of the time and Subject 2 58% of the time. Both Subjects incurred their largest error by only counting after receiving a prompt; i.e., the parent would start the child by counting the first item. Subject 1 was prompted 57% of the time in the Macquarie phase and 82% in the Self-instruction phase. Subject 2 21% in the Macquarie programme and 71% in the Self-instruction training. Subject 1 incurred the rest of her errors by counting to 1 only (18%) in the Macquarie programme. In the self-instruction phase she counted to 1 8% of the time, counted to 2 on 8% of attempts and 3 only 2% of the time. A similar pattern emerged for Subject 2 who in the Self-instruction phase counted to 2 11% and 3 18% of the time. In the Macquarie phase a frequent error (22%) for Subject 2 was to point to the first object and say 2. This did not occur in the self-instruction phase.

Subject 3 made three types of error in the Macquarie programme and two in the self-instruction phase. In each intervention the greatest error came in miss-tagging an item. In the Macquarie phase Subject 3 replaced tag 5 with tag 8 42% of the time, he used another tag 34% of the time and counted 5/5 instead of 6 on 10% of attempts. In the self-instruction phase he missed-tagged items (88%) right through the number string and counting to 5 still proved difficult (28%). There were a few small errors in both phases, such as skipping an item (Self-instruction 12%, Macquarie 5%) and double tagging an item (Macquarie 5%).

The type of error incurred by Subject 4 was very similar to that of Subject 3. Again the greatest error involved missing tags (Macquarie, 91%, Self-instruction 45%). In addition in the self-instruction phase a prompt was necessary 55% of the time. The remaining error in the Macquarie phase (9%) involved skipping items.

Subject 5 incurred his greatest error in miss-tagging items. In the Macquarie phase he miss tagged the numbers after 5 (21%) and 11 (45%). Other errors included missing 2 tags (16%), skipping items (15%) and double tagging items (3%). In the self-instruction phase miss tagging accounted for 94% of his error. This was incurred right across the number string. His other error involved skipping items (6%).

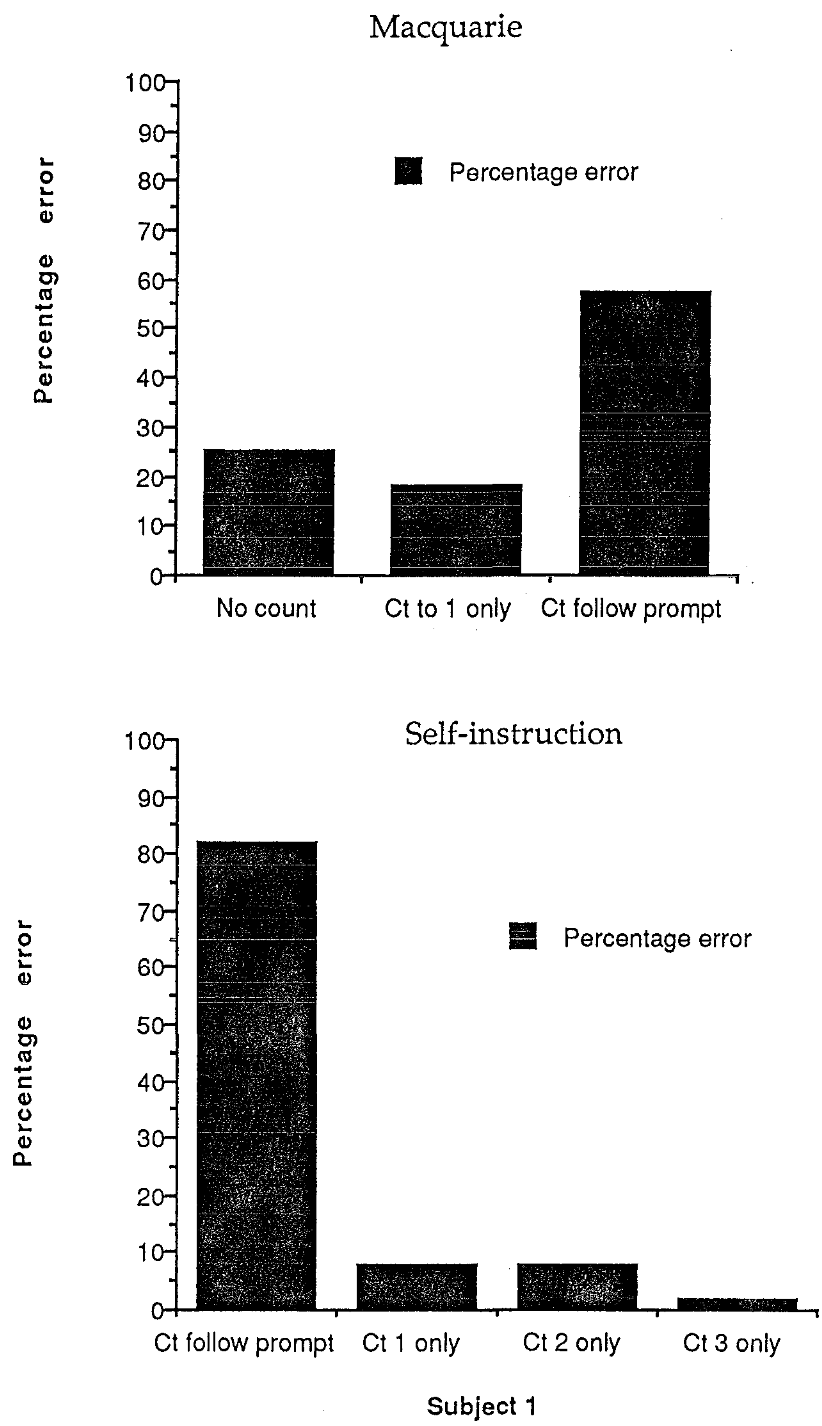
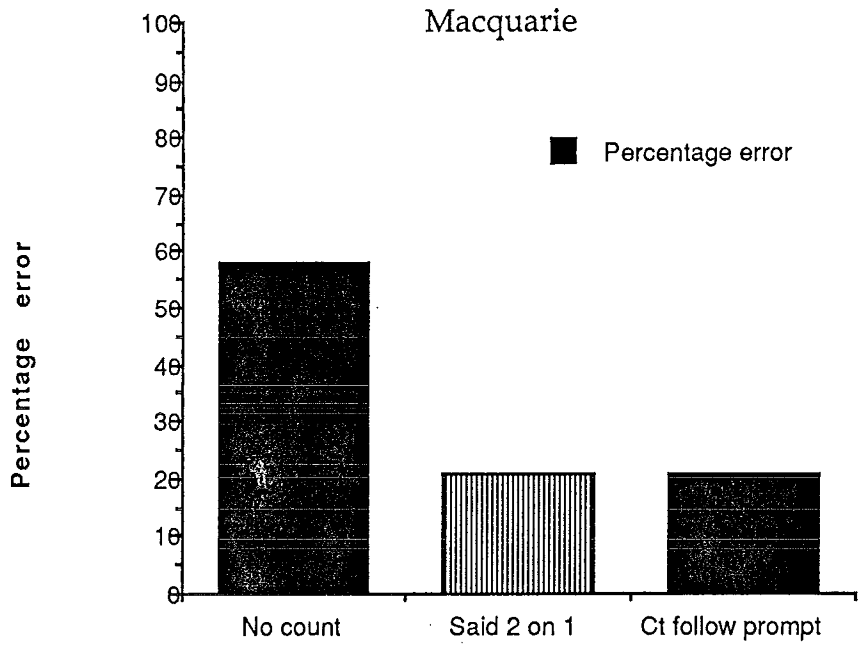


Figure 2a: Percentage number of types of errors made by subjects across the Macquarie and Self-instruction interventions.



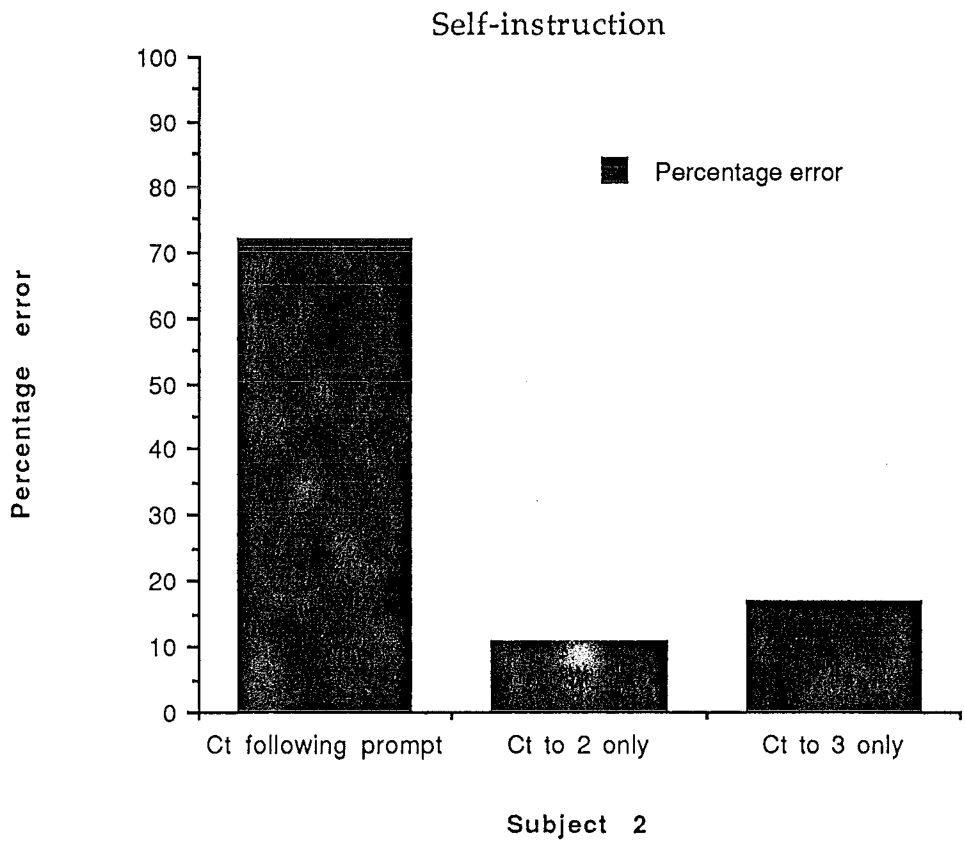
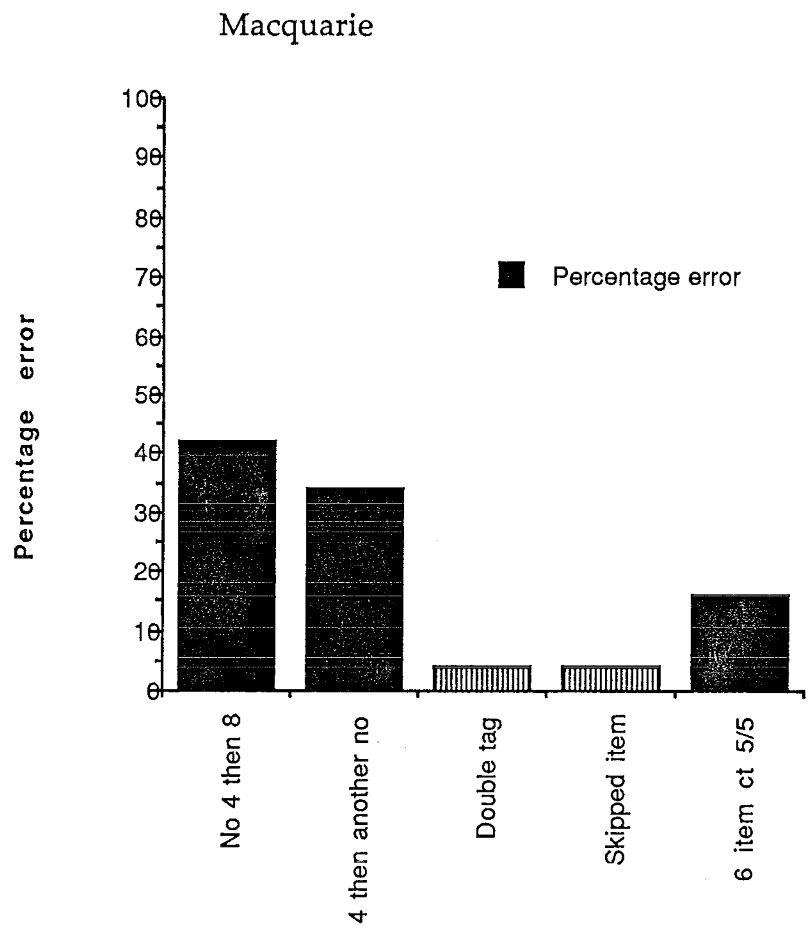


Figure 2b: Percentage number of types of errors made by subjects across the Macquarie and Self-instruction interventions.



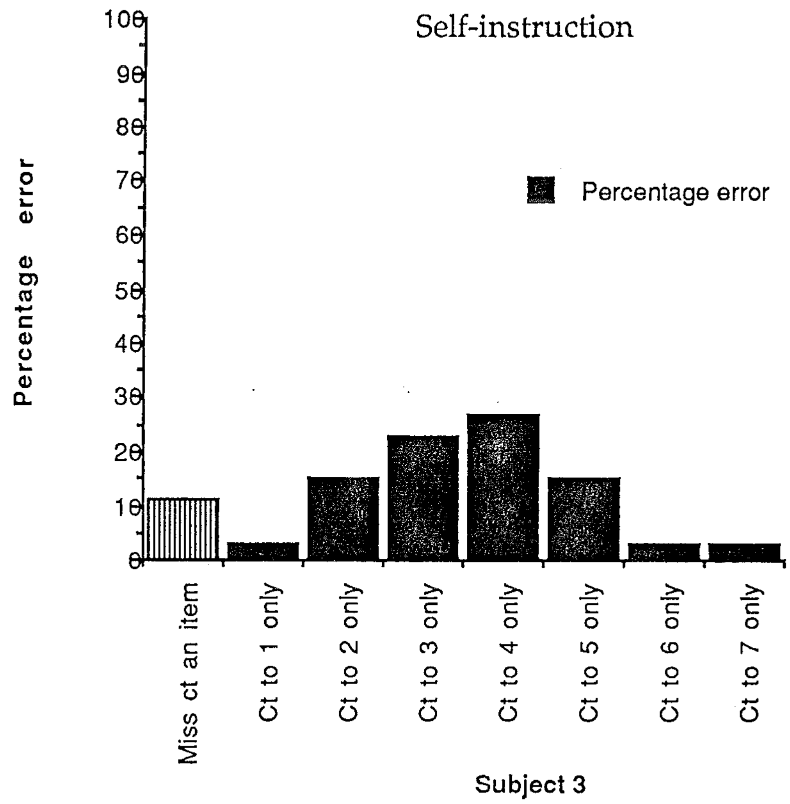


Figure 2c: Percentage number of types of errors made by subjects across the Macquarie and Self-instruction interventions.

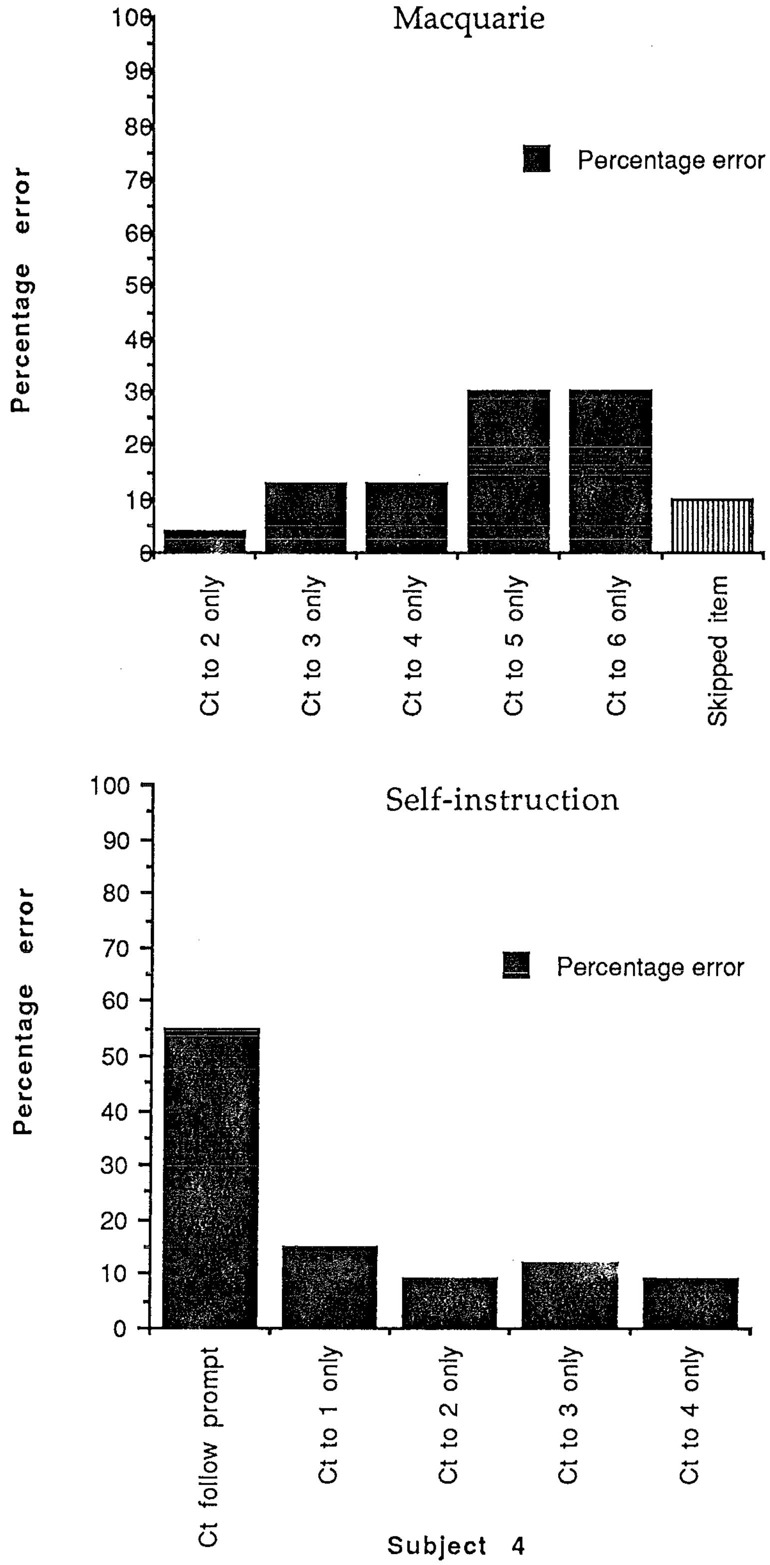
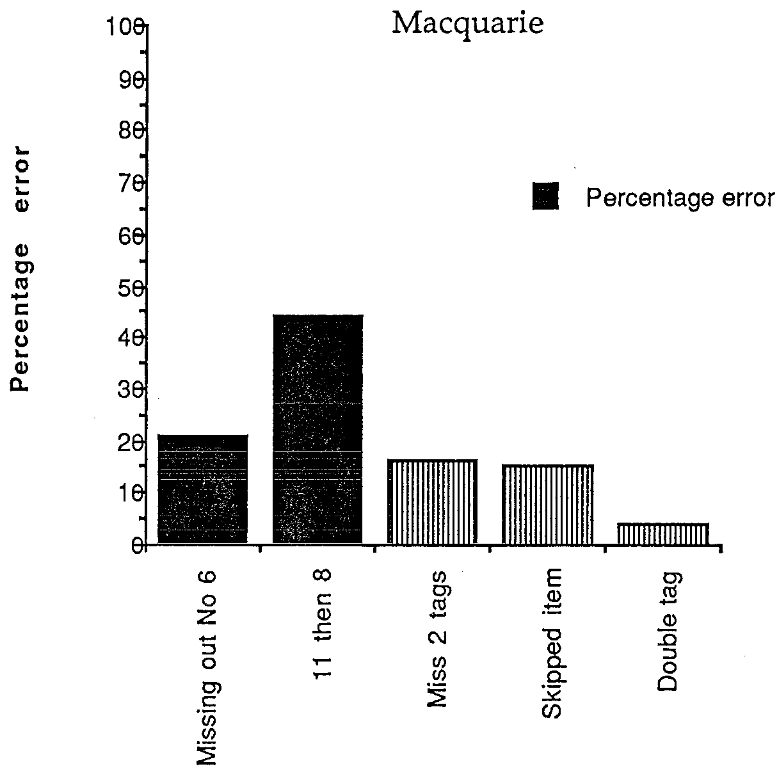


Figure 2d: Percentage number of types of errors made by subjects across the Macquarie and Self-instruction interventions.



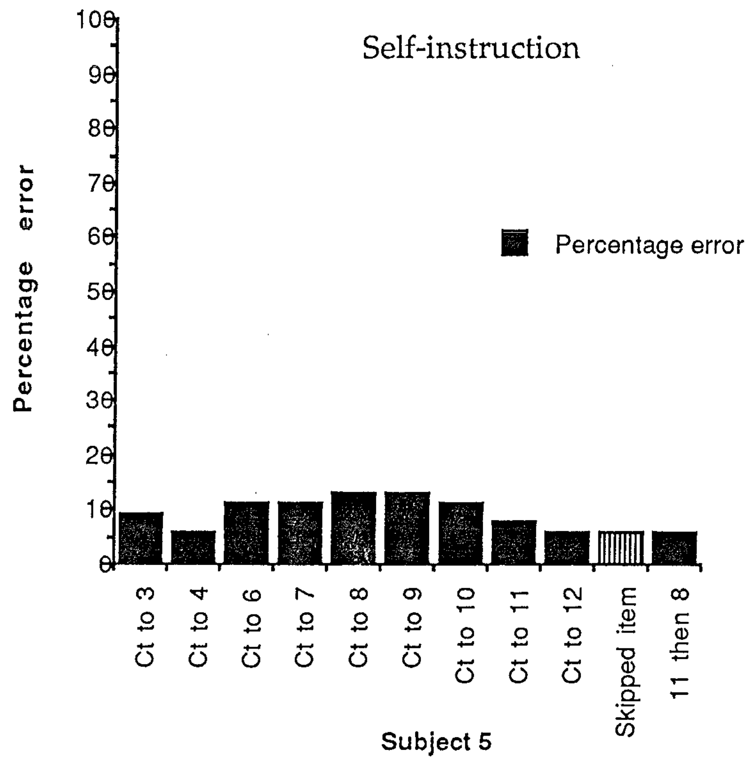


Figure 2e: Percentage number of types of errors made by subjects across the Macquarie and Self-instruction interventions.

Amount of Self-instruction and Type of prompt supplied

The mastery of self-instruction by the subjects and the type of prompt used to obtain that self-instruction is displayed in Table 4. Subjects 1 and 2 never mastered any form of independent self-instruction. Level 3 or modelling was the only prompt able to get a verbal response from these subjects. The word most frequently used by Subject 1 was "do" while Subject 2 most often used "count".

Table 4: Frequency of Self-instruction and type of prompt supplied

		Self-instruction							
Subj.	Prompt	Count	Start	Slowly	Do	Stop	Point	Gd Work	Other
1	Model	12	10		22	2			
2	Model	3	1	2			1		
	Model	7		3	1	4	3	1	7
3	Specif-Verbal			3			2		6
	Non Sp.V.	1					1		
	Indep	6		10			9	1	2
	Model			2		4			1
4	Specif-Verbal	4		25		11	29		7
	Non Sp.V.	1		3		5	23		
	Indep			1		1	4		1
	Model	4		12	6		3	7	
5	Specif-Verbal	39		33	4			5	15
	Non Sp.V.	14	1	16	1			1	7
	Indep	9		5				1	

Subjects 3,4, and 5 mastered each level of the self-instruction programme. For Subjects 2 and 5 the most verbalisation came at the specific verbal prompt level. Subject 3 verbalised the most at the independent performance level. Subject 4 used the word "point" most frequently while Subject 5 used "count" and "slowly" with most equal frequency. Subject 3 used words from the other category with the most regularity. These were words such as "beginning" and naming counting items.

Subject 5 when asked "How many" in the testing phase spontaneously used the words " count" (10 times), " slowly"(10 times) and "This is 1" (3 times). Subject 3 in the transfer of training setting used the word "count" before beginning counting.

Parent adherence to Self-instruction programme

Parents were rated on how well they followed the self-instruction programme when presenting it to their child. Percentage ranged from 65 to 95 (Mean = 80)

The sentence left out most often by parents was "_____ did good work". The sentence used most often by parents was "I must point...".

Table 5: Percentage of parent adherence to the Self-instruction programme

Subject	% Parent adherence to SI
1	65
2	96
3	71
4	96
5	70

Highest count recorded vs the No. of opportunities to count

A moderate correlation (r=.56) was observed between the highest number counted and the number of opportunities to count each subject was given. This relationship is expressed graphically in Figure 3. More data points may have meant a stronger trend would have emerged.

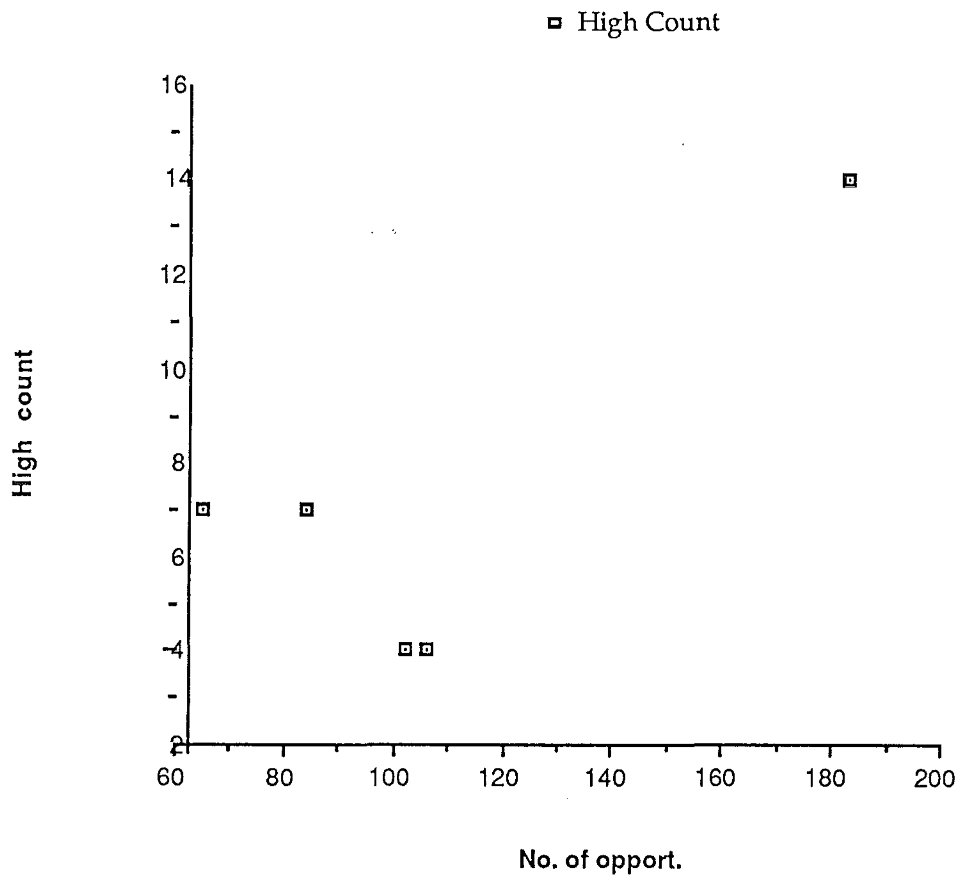


Figure 3: No. of opportunities to count vs the highest count recorded

Questionnaire

Four out of five parents responded to a questionnaire sent to elicit their opinions on this research. Answers were rated as positive, negative and neutral. Parents were asked if they felt their child's counting had improved using the Macquarie and Self-instruction programmes, what aspects they did or didn't like about the interventions and how easy they were to implement. Three out of the four parents felt their child had improved using the Macquarie and another felt no improvement was obvious.

Two parents felt the self-instruction had improved their child's counting. One commented "...especially from the point of it making him slow down his counting...", another felt there was no improvement and the fourth saw improvement in pointing to items but counting improvement was minimal. All parents liked the Macquarie programme and described it as easy to implement. The Self-instruction was considered harder to implement and two parents felt it was too wordy for their children. One felt the Self-instruction was useful as it could be applied to other tasks and another commented they were initially unsure about interrupting their child "...but after a while it did not affect their train of thought".

On the whole the Macquarie programme was perceived as good and easy to implement while the Self-instruction programme received more mixed comments.

Chapter Four

Discussion

Past research has suggested that self-instruction training is a useful procedure for teaching academic skills to persons who are intellectually disabled (Whitman & Johnson, 1983; Murphy et al, 1984). In contrast, the current study does not provide clear support for the use of self-instruction training in teaching children with Down Syndrome how to count. It tends to support Borkowski and Varnhagen (1984) view that how useful a self-instruction package is going to be is difficult to predict. However, in the current study this result may also reflect a number of limitations with the research design. Some support for interventions providing metacognitive strategies was found after a more in-depth look at the types of error made by these children.

In documenting the academic ability (with regard to counting) of children with Down Syndrome several similarities were found to previous research (Gelman & Cohen, 1988; Caycho et al, 1991) in this area. The similarities are limited to descriptors only as the present research taught counting whereas the studies mentioned above looked at the way children with Down Syndrome learn to count by testing on a variety of novel tasks. First, a wide range of counting abilities was found in both studies. Abilities in the present research were similar, ranging from Subjects 1 and 2 who were poor counters to Subject 5 who could be classified as a good counter. He showed counting skills equal to that of an average preschooler ; counting to 14 and an ability to self correct (as observed by the researcher on two occasions) on the early numbers in the number-word sequence.

Instability in the number-word sequence and coordination errors were found by Gelman and Cohen (1988). This was also true for the present group. The major type of error was with incorrect production of the number word sequence. This was in contrast to the results of McConky and McEvoy (1986) who found coordination was the major type of error for their pupils who were intellectually handicapped.

Summary of Results

During baseline sampling a wide variety of counting across subjects was recorded. This ranged from two subjects who could count no items to one who could count to ten. The introduction of the Macquarie intervention resulted in gains in counting for four out of the five subjects (three subjects improved by counting two more items and the other one improved to count an extra item).

In comparison, the self-instruction did not appear to be as successful. Three subjects improved to count two more items (although two of those subjects did not master the self-instruction programme) and the other two subjects showed no improvement. Overall, during both interventions subjects tended to be unstable in their production of the number-word sequence. As mentioned above, the major type of error that occurred in both intervention phases was that of sequencing or incorrect production of the number word sequence. Co-ordination errors were also noted (mainly in the Macquarie intervention). The introduction of the self-instruction programme resulted in fewer coordination errors for one subject (Subject 5 decreased his coordination errors from 36% to 6%) and the complete removal of this type of error for two other subjects.

Three out of five subjects mastered the self-instruction at an independent performance level. One Subject (subject 5) spontaneously self-instructed during the testing phase and another (Subject 3) said "count" in the transfer of training setting. The other two subjects did not master the self-instruction at a level beyond repeating the word after it was modelled for them. The self-instruction programme was implemented well by parents (mean accuracy = 80%). This result would suggest that parents can be incorporated successfully as trainers in a self-instruction programme. A moderate correlation was observed between the highest number counted and the number of opportunities to count each subject was given. Subject 5, who proved to be the most competent counter had almost double the opportunity to count of the four other subjects. This tends to support the point that Gelman and Cohen (1988) make about "other variables" , such as context, playing a part in the academic ability of children with Down Syndrome. When differences are found between children with Down Syndrome and other children it can not be automatically assumed they are due to genetic make-up.

In the transfer of training setting no clear trend emerged. After both interventions were implemented success was mixed. Three subjects remained the same as they had been in baseline following both interventions. One subject improved his performance after both procedures and the other subject decreased his performance from baseline after the Macquarie but increased (to his target number of 14) his performance after the self-instruction intervention.

From the results a number of points of interest were noted for individual subjects. Subjects 1 and 2 did not master any form of independent self-instruction and yet both consistently reached their count target of four in the testing phase. Evidence suggested that coordinating the count word sequence had improved for both children during the self-instruction intervention. This improvement is recorded in Figure 2b for subject 2 and is anecdotal for subject 1. The mother reported in the questionnaire that self-instruction had improved the child's pointing and it was noted from the audio tape that the mother had sometimes assisted the child with pointing during the Macquarie programme but this was not necessary for the self-instruction procedure.

After both interventions Subject 3 showed no improvement from baseline. Anecdotal evidence would tend to support the view that his failure was due primarily to a motivational factor. The audio tape recorded his mother challenging him on seven occasions (with words such as "pardon" and "think") when he produced an incorrect number word sequence. These challenges produced the correct number word sequence. His teacher also reported his resistance with number work.

Subject 5 appeared to benefit most from the self-instruction. Towards the end of the self-instruction training a gradually improving and stable trend emerged. This is supported by his results in the testing phase (although only three points are shown on the graph) he counted correctly to 14 while self-instructing on 11 out of 15 occasions. This view is further supported by anecdotal evidence from the questionnaire, transfer of training success and reduction of coordination errors after the self-instruction intervention. Following the line of Whitman's (1987) theoretical argument it could be assumed that Subject 5 was using words to guide and regulate his pointing action, and using the "What is it I have to do" statement as a problem solver when faced with a counting task in any setting.

Issues raised by the results

Wishart and Duffy (1990) consider motivation is a factor in performance on tasks by children with Down Syndrome. The results from the present study would support this finding. Evidence of tasks-avoidance tactics was found in four out of five subjects. On many occasions Subjects 1 and 2 did not offer a count (see Figures 2a-b). This was the case even when the counting sequence was modelled. This makes it difficult to argue a lack of knowledge was responsible for their silence. Subject 3 did not improve and yet when challenged would produce the correct number word sequence. His stable responding could be consistent with Wishart and Duffy's (1990) view that only a narrowly defined range of items tends to be reliably passed. Throughout the study Subject 4 produced the most unstable counting sequences. Any attempt to use the audio tape would result in task avoidance. To overcome this difficulty the tape recorder was turned on without his knowledge. Some avoidance tactics were still evident, such as not coming to the table when called, and eventually another member of the family was enlisted to encourage the procedure by also having a turn at counting.

Consistent with the findings of Rietveld (1989) the number word sequences for the majority of the subjects were unstable. This instability could be for a number of reasons as Rietveld has (1990) argued; motivation, poor short term memory or lack of schema for a task. Poor schema for the task could be explained by poor-short term memory, eg., Subject 5 appeared to have most difficulty in remembering items in the middle of the number-word sequence rather than the beginning or the end.

A number of studies suggested an intervention which teaches metacognitive skills will help children develop an implicit and explicit understanding of number. More specifically to coordinate the verbal counting with pointing (Caycho et al., 1991) and slowing down counting (Baroody, 1987). Some support for this theory was found in the current study. First, a decrease in coordination errors occurred for four out of the five subjects. Teaching children to point to each object as they said the number word sequence gave them a skill for improving accuracy, a skill not acquired incidentally by these children. Secondly, Subjects 1 and 2 appeared to benefit from the self-instruction programme without independently self-instructing. One possible explanation for this success is that by providing an executive skill missing from the child's existing repertoire, for example, pointing to an object, a framework was developed which helped consolidate the counting knowledge into a firmer and more meaningful schema for the task. In this case producing a successful outcome. It could be argued against this view that Subjects 3 and 4 did not appear to benefit in this way. However, in their case it is more likely the self-instruction had not become an automatic process and was interfering with the counting task. Not enough opportunities to count may explain this result. In support of this view is the evidence from Subject 5. He was only just showing a stable trend by the end of training and he had many more opportunities to count than the other subjects and his self-instruction programme was less verbal and therefore easier to acquire. Borkowski and Cavenaugh (1978; cited in Schelser et al., 1981) argue that the likelihood of maintenance and generalisation increases when training is prolonged and conducted in depth. However, it may be as Whitman (1987) notes:

> "...because retarded children, like their non-retarded peers, vary considerably in their level of development, it is important that they not be viewed as a population who will be homogeneous in their response to cognitive-behavioural, educational programs such as self-instruction training". (p.221)

In the current study the results may reflect the wide range of knowledge for the task and language exhibited by the subjects.

Limitations of Study

A major limitation was the failure of two of the subjects to master the self-instruction programme. As this was the case, the benefits of self-instruction as an intervention for these two subjects can not be assessed. This failure to master the self-instruction was probably a fault with the research design . More extensive pretesting should have been undertaken. Only one pretest of pointing ability was taken and both subjects appeared successful, yet during the early stages of the research neither subject showed this ability. In this case, starting with such a limited skill base perhaps the self-instruction could have been simplified to train just this one skill (pointing) to go with the counting. Also providing a visual stimulus and therefore working to their strengths, i.e., visual memory, may have led to more success.

Secondly, the research required a long period of effort from parents and children. Parents were only able to put in as much time as they could spare and only the mother of Subject 5 was able to give her child enough opportunities in the time available for the research to see a successful pattern emerge from the self-instruction intervention. A study teaching counting only using a self-instruction intervention (such as Bates et al., 1984) may have proven more conclusive.

The small sample size must mean any conclusions drawn are only tentative. This is particularly so as the results are mixed and so any evidence is based on only one or two subjects. In light of Wishart and Duffy (1990) finding that motivation is a factor that must be taken into account when looking at the competence in performance of young children with Down Syndrome, at least one more probe for generalisation in the transfer of training setting should have been implemented. Any argument on the strength of self-instruction and metacognition in developing meaningful strategies would have been strengthened with a six month follow up. This is particularly so in the case of Subject 5 who mastered the self-instruction.

Although tape recording was useful, video taping would have made analysis of the types of error occurring more reliable. Tape recording relied on the parents explaining the mistake made to the child. Errors could have been missed if parents just started the child again without explaining the mistake.

Future Research and Conclusions

The unclear results found in the current study, the small number of empirical studies on the academic ability of children with Down Syndrome and the new areas of self-instruction and metacognition allow plenty of scope for future research.

The current study looked at counting and children with Down Syndrome without reaching any conclusions. Documenting other aspects of numerical ability for children of this age would be useful, particularly in light of the developments, such as Early Intervention programmes, only recently given to these children. Other issues of interest arising from the literature would be to explore the many variables responsible for rendering children with Down Syndrome apparently poorer in ability at maths than in other skills and a replication of Caycho et al., (1991) findings that children with Down Syndrome can develop an implicit and explicit understanding of number.

The current study found two children appeared to benefit from the modelling of metacognitive strategies. A number of research studies have indicated that teaching metacognitive skills would be beneficial to children with Down Syndrome. A possible explanation was provided for this result, however, at best it was only an educated guess. Future research is needed to look at this specific point. Can children with Down Syndrome acquire the metacognitive skills they lack through modelling and prompting this type of instruction?

Self-instruction was found to be of benefit to one subject in the current study. To date this is the only study which has used this type of intervention with children with Down Syndrome. Future research needs to continue to look at the utility of self-instruction with children with Down Syndrome across a wide range of tasks, ages and abilities.

Overall, this research has produced more questions than it has answered. However, it has continued to document the academic ability of children with Down Syndrome. The more studies that can do this the greater the arguments against the negative stereotypes that still persist. Although not providing clear support for self-instruction or the use of metacognitive strategies, enough positive possibilities have been raised, supported by theoretical ideas and the failure of traditional methods to produce generalisation and maintenance, to make this a worthy area for future research.

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Appendices

Appendix A

INFORMATION FOR PARENTS

What is the aim of this project?
To investigate self-instruction as a way of teaching counting to children with Down Syndrome.

What is required of parents?
To teach very simple counting and self-instruction skills to their child. This will take 5-10 minutes a day for as many days a week you can manage (minimum 1 to maximum 5) for a period of about 2 months.

What is self-instruction?
In the past, self-instruction, has been successfully employed to develop specific academic skills such as handwriting, reading comprehension and mathematics. It is a process of providing one's own verbal prompts. Many adults provide prompts for themselves when participating in difficult or unfamiliar tasks, for example, performing a complicated dance step. In this case the verbal prompts or self-instruction scripts will be provided for the children.

How does it work?
There will be three steps used. These are:
1. The adult demonstrates counting to the child while talking out loud about the task.
2. The child performs the same task under the direction of the adult.
3. The child performs the task (counting) while instructing him/herself aloud. The instruction can be as simple as one word.

Why should it benefit these children?
In general children with Down Syndrome do not achieve as well at school as other children. Research compiled by Christine Reitveld, among others,has suggested one reason for this maybe their failure

to acquire appropriate learning strategies and/or their failure to recognise, then apply the strategies they have already. This is called a metacognitive deficiency. Self -instruction (putting together what students are doing with what they are saying) assist by providing the general information or strategies needed in problem solving.

How will this be shown?

To show that self-instruction assists children with Down Syndrome it needs to be compared with another method of teaching. The Macquarie programme has been chosen because it is a successful method for teaching mathematics. The programme is similar to that used at Early Intervention. In the first phase of the project, counting will be taught using the Macquarie programme. In the second phase self-instruction will be added to the programme. According to the theory counting should be significantly better in the second phase.

How will this help your child?

In the short term it may improve your child's ability to count. In the long term, as we add to the research , it may assist children with Down Syndrome with all aspects of academic work.

PLEASE FEEL FREE TO ASK ANY QUESTIONS.

Phase 2: The Macquarie Programme

The Macquarie programme was designed in order to teach a group of pre-school Downs syndrome children a set of minimal number skills which would facilitate their integration into the kindergarten class of a regular school.

Instructional Procedures

Each skill involves a large number of complex components, especially for very young children, so that little or no learning would occur if the whole task is presented at once. Therefore, each task is broken down into substeps. The methods used throughout the Macquarie teaching sessions were the behaviour change techniques of modelling, prompting, shaping and reinforcement. A brief account of these techniques are:

Modelling:

When the teacher requires a child to act she says or does something to him, e.g. teacher says "say one" (verbal cue), then teacher says "one" (modelling) which helps John make the correct response, i.e. he says "one".

Prompting

If the child does not respond, the teacher may physically help the child, e.g. in teaching pointing she would take the child's hand and make it point. This is a physical prompt. It is sometimes called the "hand-on-hand" method. It should, of course, be gradually faded out as the child learns to do a task herself.
Other prompts may be visual, e.g. teacher says " Be quiet" and then puts her finger on her lips. A verbal prompt would be the sound "t" after giving the cue "two". Teacher says "Say two"

Child - no response
Teacher says "t.....?" (verbal prompt)
Child says "two"

Shaping

After the child responds there should be an immediate reward or reinforcement. The teacher says " Good boy" or " yes, - 'two'-that's right".

Initially the child may not make a totally correct response, so the teacher rewards the child for responses which are partly right. This is defined as "shaping". A child learning to write makes a very awkward shape for the number 3. In the initial phase the teacher will reward his awkward attempt, then gradually withhold the reward on the following trials until his letter is the required standard.

Reinforcing

The reward or reinforcement is the event (or consequence) which follows the child's response, and which affects the child's future behaviour. To increase or improve the child's response behaviour the teacher reinforces or rewards it.

Social reinforcement in the form of praise, smiles, applause and the like are constantly used with all children.

Reinforcement in the form of stamps, stickers and food will be provided.

The Macquarie technique for teaching counting is as follows:

Count concrete objects in ordered array 1-5

Objective: Given a set of concrete objects, placed in a row, the child will
count the objects 1-5, given the verbal cue "Count the blocks".

Materials: Any three-dimensional objects-cars, blocks, etc.

Procedure: Put 5 blocks in a row with space between

(1) Teacher says to child "Count the blocks".

(2) Child has to point to each block in turn saying the correct number "one, two, three, four, five".

Ensure that child points once only to each block in correct sequence and that she stops counting after the last block. Commence with small number of objects and gradually expand to 5 objects.

Possible substeps are as follows:

(1) Teacher models counting technique. Puts out two blocks and says " I'm counting two blocks -points- one, two". Says " I'm counting three blocks- points - one, two, three. Model a number of examples and then go back to specifics with the child.

(2) Teacher models and the child imitates the teacher. Puts out two blocks "Let's count two blocks -one, two". Child has to point and repeat "one,two".

(3) Child counts two blocks given verbal cue " count the blocks"

The above substeps are repeated for teaching counting to 3,4 and 5. Steps may need to be adjusted, smaller or larger depending on each child's response.

Please record each session.

Self-Instruction

The third phase of the project involves teaching counting using self-instruction. Each session should be about 5-10 minutes. Please tape each entire session.

Session 1 and 2: The teacher models the task while verbalizing the self-instruction steps aloud. Please model the task three times during each session. Each time a different set of objects should be used, for example you might model counting firstly with blocks, then with cars and then with cups.

To begin, obtain the child's attention. Please do this before starting each
time.

-----------, I want you to listen and look at what I am going to do. Are you ready? Wait till the child nods or gives you whatever you normally accept as their signal they are paying attention.

Follow this with the self-instruction steps. They are:

Ok, What is it I have to do? I have to count the cars (or whatever the objects are).
I have to start at this end and go slowly.
I must point to the first car . This is 1.
I must go slowly then point to the next car. This is 2.
I must point to the next car this is 3.
I must go slowly then point to the next car this is 4.
I must point to the next car . This is 5.
This is the last car and so I stop counting.
.................., did good work.

Sessions 3 and 4: The child does the actions while the teacher instructs aloud, i.e. the child points and counts as the teacher verbalizes each part. When the child reaches a number they haven't learnt to count the teacher models this number and gets the

child to say it out loud. Please continue to reinforce them for counting correctly, i.e with stars, stamps or social praise.
If the child makes an error bring them back to the point where the error was made. Ask them "What number was this?" If they do not know say "Watch what I do" and provide them with the answer. If after 3 attempts they still make the same mistake repeat the session from the beginning.

Sessions 5 and 6: The teacher models correct performance of the first line i.e " Ok, What is it I have to do? I have to count the cars" then the student self-instructs following the teacher. Please reinforce the child for anything he or she says which approximates the above sentence. Then, as in session 3 and 4, the child does the actions while the teacher instructs aloud.

In the following sessions the child learns the self-instructions line by line. For example in sessions 7 and 8 the child would give his/her approximation to " Ok, What is it I have to do? I have to count the cars " and then the teacher models the second line " I have to start at this end and go slowly" then the student self instructs following the teacher. Please reinforce the child for anything he or she says which approximates the above two sentences. Please do reinforce, even if you are doubtful about the approximation. To aid learning, it is important to be generous at this stage. Then, as in session 3 and 4, the child does the actions while the teacher instructs aloud.

Self-Instruction (Subject 5)

The third phase of the project involves teaching counting using self-instruction. Each session should be about 5-10 minutes. Please tape each entire session.

Session 1 and 2: The teacher models the task while verbalizing the self-instruction steps aloud. Please model the task three times during each session. Each time a different set of objects should be used, for example you might model counting firstly with blocks, then with cars and then with cups.

To begin, obtain the child's attention. Please do this before starting each time.

-----------, I want you to listen and look at what I am going to do. Are you ready? Wait till the child nods or gives you whatever you normally accept as their signal they are paying attention.

Follow this with the self-instruction steps. They are:

Ok, What is it I have to do? I have to count the cars (or whatever the objects are).
I have to start at this end and go slowly.
I must point to the first car . This is 1.
2,3,4,5
I must go slowly.....6
7,8,9,10,11,12,13,14.
This is the last car and so I stop counting.
.................., did good work.

Sessions 3 and 4: The child does the actions while the teacher instructs aloud, i.e. the child points and counts as the teacher verbalizes each part. When the child reaches a number they haven't learnt to count the teacher models this number and gets the child to say it out loud. Please continue to reinforce them for counting correctly, i.e with stars, stamps or social praise.

If the child makes an error bring them back to the point where the error was made. Ask them "What number was this?" If they do not know say "Watch what I do" and provide them with the answer. If after 3 attempts they still make the same mistake repeat the session from the beginning.

<u>Sessions 5 and 6:</u> The teacher models correct performance of the first line i.e " Ok, What is it I have to do? I have to count the cars" then the student self-instructs following the teacher. Please reinforce the child for anything he or she says which approximates the above sentence. Then, as in session 3 and 4, the child does the actions while the teacher instructs aloud.

In the following sessions the child learns the self-instructions line by line. For example in sessions 7 and 8 the child would give his/her approximation to " Ok, What is it I have to do? I have to count the cars " and then the teacher models the second line " I have to start at this end and go slowly" then the student self instructs following the teacher. Please reinforce the child for anything he or she says which approximates the above two sentences. Please do reinforce, even if you are doubtful about the approximation. To aid learning, it is important to be generous at this stage. Then, as in session 3 and 4, the child does the actions while the teacher instructs aloud.

Dear

Thank you for your continued cooperation in this research. We are now in the final 3 weeks of the study.

Up to this point we have been teaching the children with what is called a specific prompt, for example, " I have to start at this ......" and the child responds "end". To help the child become more independent, the next step is to provide them with non-specific prompts, for example:

Parent: What do you have to do?

Wait 5 seconds for the child to respond.

If the child responds	If the child does not respond
Child: "Count" (praise them for this)	Provide them with the answer

Parent: What next?

Wait 5 seconds for the child to respond.

If the child responds	If the child does not respond
Child: " End" or whatever word they have been selecting from the second line. Praise them.	provide them with the answer

Parent: What next?

Wait 5 seconds for the child to respond.

If the child responds	If the child does not respond
Child: "Point" or whatever word they have been selecting from the third line. Praise them.	provide them with the answer

Please continue to follow the same process throughout the self-instruction.

After three sessions of non-specific prompts we will assess how the child is learning.

Hopefully, we will then move to finishing off the research.

Finally, to finish off the research please record three sessions over three days of your child counting. Please count different objects on different days and do not prompt or assist your child in any way.

Thank you.

Appendix B - Questionnaire

Thank you for participating in the research on counting . Now that it is finished , I am interested in finding out what you thought of the Macquarie and self-instruction programmes. You can help me by answering the questions set out below. Your comments, both positive and negative, will assist in improving future research in this area. Please post it back to me in the envelope provided. Thank you for your time.

1. Did you feel your child's counting improved using the Macquarie programme (the first method of teaching) ? If the answer is no, were there any gains made in other areas, for example the child pointing to the correct item while you counted.

2. Were there any aspects of the Macquarie programme you did or did not like?

3. Did you feel your child's counting improved using the self instruction programme? If the answer is no, were there any gains made in other areas, for example the child pointing to the correct item while you counted.

4.Were there any aspects of the self-instruction programme you did or did not like?

5. How difficult to implement did you find :

a) the Macquarie programme

b) the Self-instruction programme