Gender Ratio in Dyslexia

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This paper is based on a study carried out in Great Britain on a national sample of 11,804 ten-year olds. The first section describes an attempt to pick out cases of "specific developmental dyslexia" (Critchley 1970), a constellation or syndrome of difficulties which some believe to be recognizable clinically. When specified criteria for dyslexia were used, 269 children qualified as dyslexic (2.28 percent of the sample). These included 223 boys and 46 girls, for a ratio of 4.51 to 1. Two possible difficulties in interpreting these data are discussed, and a defense is offered of the criteria used.

Since some recent research papers report a gender ratio much nearer 1:1 (Shaywitz et al. 1990; Wadsworth et al. 1992; Lubs et al. 1993), those papers were examined for possible differences in procedure; it was found that the definition of dyslexia they used was "poor reading in relation to intelligence." We carried out a further analysis on our own data using the same criterion. Of the 494 children who qualified as dyslexic on the

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basis of discrepancy criteria alone (4.19 percent of the sample), 314 were boys and 180 were girls for a ratio of 1.69 to 1. It seems, therefore, that the apparent differences in gender ratio reported in the literature have arisen because different criteria for dyslexia have been used.

We argue that the definition based on clinical criteria leads to a more powerful taxonomy and that the widespread equation of "dyslexia" with "poor reading" is a hindrance to progress.

INTRODUCTION

It has traditionally been supposed that there are many more dyslexic males than females (Hinshelwood 1917; Hallgren 1950; Hermann 1959; Critchley 1970; Goldberg and Schiffman 1972; Hier 1980; Finucci and Childs 1981). More recently, however, this imbalance has been called into question (Shaywitz et al. 1990; Wadsworth et al. 1992; Lubs et al. 1993).

The data presented in this paper are in agreement with traditional accounts in finding a preponderance of males when clinically based criteria for dyslexia are applied. These criteria include not only poor reading and spelling in relation to general intelligence, but also such clinical indices as uncertainty over left and right (a phenomenon first noted by Dr. Samuel Orton) or difficulty in the recall of auditorily presented digits. On the other hand, if a diagnosis of dyslexia is based solely on measures of reading and intelligence, making what we argue to be an unwarranted equation of dyslexia with specific reading retardation, we also found the gender ratio to be closer to 1:1.

For ease of communication, we shall distinguish between "specific developmental dyslexia" (SDD), a condition diagnosed on multiple criteria of a clinical kind (Critchley 1970), and "specific reading retardation" (SRR) (Rutter and Yule 1975), which refers to poor reading in relation to intelligence.[1]

The data which form the basis of the present paper were collected in 1980 and relate to 11,804 ten-year olds. This body of data will be referred to in what follows as the "British Births Survey." The size of the sample and the fact that it targets a complete population has provided a unique opportunity for an

[1] The expression "SDD" is new to the present paper: in earlier papers the participants were described simply as "dyslexic". In the present context, however, this would be question-begging—as would the expressions "genuine dyslexic", "proper dyslexic", etc.,—since the question of the relative merits of the SDD and SRR concepts is precisely what is at issue. The expression SRR can be treated as equivalent to what in the United States is termed RD (reading disability).

investigation of dyslexia. The following publications have already appeared: Miles and Haslum (1986); Haslum (1989); Miles (1991); Miles, Haslum, and Wheeler (1993, 1996, 1997); Miles, Wheeler, and Haslum (1994). Analyses of the data are ongoing and further papers are in preparation.

The primary objective of the dyslexia component of the research was to find a formula which, if consistently applied across the cohort, would pick out those children showing strong evidence of SDD. The underlying assumption was that children with dyslexia can be recognized by persons with relevant clinical experience including doctors, teachers, psychologists, parents, and many individuals who are themselves dyslexic. We also assumed that the early pioneers—Hinshelwood (1917), Orton (1937/1989), Hallgren (1950), Hermann (1959), and Critchley (1970)—were talking about the same group of children. Our research goal, therefore, was to sharpen the definition of the concept that these early researchers referred to without radically changing it. To adapt some wise words used in a different context by the philosopher, Sidgwick (1922), "A definition may be given . . . which will be accepted by all competent judges as presenting, in a clear and explicit form, what they have always meant by the term, though perhaps implicitly and vaguely. In seeking such a definition we may, so to speak, clip the ragged edge of common usage, but we must not make excision of any considerable portion" (p. 264).

To put the matter another way, our intention was to *operationalize* clinical judgments of SDD. We hoped not only to specify operations which would distinguish children with SDD from others with literacy problems, but to show that the differences between them were important and could be used as the basis for a meaningful taxonomy (classificatory principle).

PARTICIPANTS AND METHOD

The data for the analyses presented in this paper are taken from the ten-year follow up of the British Births Survey including all live births which occurred in England, Wales, and Scotland between April 5th and 11th 1970 (Chamberlain et al. 1975; Chamberlain et al. 1978). This was the third of the British national perinatal longitudinal studies. The study of the 1970 cohort at around birth, and the nationwide follow-up studies at age five (Osborn et al. 1984; Butler et al. 1986) and at age ten (Butler et al. 1982a, 1982b) have been extensively described.

Children were traced at the age of ten by the use of three processes. The research team held manual indices on the children from the birth survey, the nationwide five-year follow up, and a seven-year follow up that had traced an additional 1917 children not contacted at age five. A computer file was set up for all known living children in the cohort. The cohort children were flagged at the Office of Population Census and Surveys and the cohort team was automatically informed of deaths and migrations.

For the ten-year study, children were traced through Family Practitioner Committee records. The Area Health Authority (public health nurses) contacted families requesting consent to participate in the follow up, and interviewed the parents or parent figure.

The children were also traced through school records. Trace forms were sent to every Local Education Authority and independent primary or middle school in England, Scotland, and Wales (Northern Ireland was omitted from the five-, seven-, and ten-year follow-up studies). The schools provided the name, address, and date of birth of the children; they also provided the name of the parent or guardian who was then sent a letter requesting participation in the educational part of the survey.

In addition to the educational testing, school doctors took medical histories, carried out general physical examinations, and tested motor coordination; hearing and visual acuity were also tested. Health visitors interviewed parents to collect structured medical, family, and social histories; and mothers completed behavior scales and skills scales about their children. Classroom teachers also rated the children's behavior and skills, administered educational tests, and commented on their educational needs.

The present paper is limited to a selection of the educational data which were obtained by classroom teachers when the children were ten years old; data were scored by members of the research team. The tests of achievement included a word recognition test which involved the reading of single words out of context, a test of reading comprehension (the Shortened Edinburgh Reading Test, later published by Hodder and Stoughton in 1985), and a spelling test in the form of a dictation. (See Appendix I for details about the tests.)

In selecting appropriate measures of intelligence, we took into account clinical experience and research evidence specific to children with SDD (compare Miles 1996). As a result of the so-called ACID profile (weakness at the Arithmetic (A), Coding

(C), Information (I), and Digit Span (D) sub-tests of the Wechsler Intelligence Scale for Children) global IQ scores of SDD children tend to be depressed (see, for instance, Miles and Ellis 1981). SDD children also show uneven profiles on the British Ability Scales (BAS) (Elliott, Murray, and Pearson 1979, 1983). For example, Thomson (1982) reports that at three different ages, persons with dyslexia performed consistently well on the Similarities and Matrices subtests, and consistently poorly on Recall of Digits and Speed of Information Processing.[2] For these reasons, we assessed intelligence in the present study by using the combined score on the Similarities and Matrices subtests. In the Similarities test, the child has to explain how three things are alike, then produce a fourth of the same kind (for example, given *horse, cow,* and *sheep,* a child should respond "they are animals", and produce a fourth such as *pig*). The Matrices test was of the standard variety: the child had to recognize relationships between figures and then choose, from a number of alternatives, the correct figure to fill a vacant space. To provide a common measure for comparison, the scores on the word recognition and spelling tests, and the combined score on the Similarities and Matrices, were standardized so as to give a mean of 100 and a standard deviation of 15; they were not normalized.

To supplement these measures of achievement and general cognitive function, we also presented four tasks which our clinical experience had suggested were indicative of specific developmental dyslexia (Miles 1993). These included the Recall of Digits subtest from the BAS (Elliott et al. 1979, 1983), and three subtests from the Bangor Dyslexia Test (Miles 1982, 1997), such as Left-Right (which involves items like "point to my right ear with your left hand"), Months Forwards (where the months of the year have to be recited in forward order), and Months Reversed (where they have to be recited in reverse order). Resources did not allow for the Bangor Dyslexia Test to be given in full, and the items chosen were those which could most easily and reliably be administered by classroom teachers. (Appendix II presents relevant items from the Bangor Dyslexia Test and instructions for scoring.)[3] Since our intention was to

[2] These subjects were assessed at Aston University where research on dyslexia (in the SDD sense) was being pioneered. Although the words "specific reading difficulty" appear in the title of his paper, Dr. Thomson (personal communication) has assured us that the children in this study met traditional criteria for dyslexia.

[3] The two Memory for Digits items (forwards and reversed) from the Bangor Dyslexia Test would have been largely superfluous since the Recall of Digits subtest from the British Ability Scales had already been included.

use the BAS Recall of Digits subtest alongside the Bangor Dyslexia Test, rather than as a measure of intelligence, these scores were converted so that, like the Bangor items, they too could be scored as "plus", "zero", or "minus."[4]

CRITERIA FOR SDD

In selecting criteria for SDD, we took the view that defining dyslexia as "poor reading in relation to intelligence" was not so much wrong as incomplete. Children can be poor readers for many different reasons, including lack of motivation or absence from school. To classify such children as dyslexic, which implies some kind of biological basis for their difficulties, seems at variance with traditional usage and unlikely to lead to any worthwhile taxonomy. On this point, we quote the words of Galaburda (1992):

> Lumping together all children with discrepancies between reading skills and intelligence makes no more sense than lumping together all persons with high blood pressure (p. 279).

Our task, within the resources available, was to try to identify children who would have been recognized as classic cases of dyslexia (in the SDD sense) had a fuller assessment been possible. Since SDD is widely agreed to involve difficulty with the *decoding* aspects of reading and writing, we chose to assess reading using the single word recognition test rather than the Edinburgh Reading Test, which relies more heavily on comprehension. We also decided that more importance should be attached to weakness in spelling than to weakness in reading.

To pick out poor readers, each child's word recognition score was regressed on his or her combined score on the Similarities and Matrices items. To obtain the best fit for the regression lines, outliers beyond 1.5 standard deviations from the mean were excluded; the equations were recalculated on the remainder and then refitted to the entire population. Residual scores (observed –predicted) were then calculated for each individual. Those children whose residuals were between

[4] The decision was taken to score this item in relation to intelligence. This was done by converting the standardized Recall of Digits scores into z-scores (referred to as z.RD, RD meaning Recall of Digits) and creating z-scores on the combined Similarities-Matrices score (referred to as z.SM, SM meaning Similarities and Matrices). For each individual, a value was determined (z.RD minus z.SM) and the mean and standard deviation were calculated. If a result was less than –1.5 SD it was scored as plus; if it lay between –1 and –1.5 it was scored as zero, and if it was greater than –1 it was scored as minus.

1.0 and 1.5 standard deviations below prediction were described as "moderate underachievers"; those whose residuals were outside 1.5 standard deviations below prediction were described as "severe underachievers." The procedure was repeated for spelling scores. As a result, it was possible to identify "normal achievers" at both word recognition and spelling, and to distinguish them from "moderate underachievers" and "severe underachievers."

Our emphasis on spelling was based on our own clinical experience. We knew, in particular, that by the age of ten-years, some children, who in other respects showed clear signs of SDD, were nevertheless reasonably adequate readers (Miles 1993, Chapter 8). Not only did Naidoo (1972) find it necessary to distinguish dyslexics who were poor at both reading and spelling from those who were poor at spelling only, but it is clear that many college students with dyslexia struggle with essay writing, note-taking, or the memorization of formulae without finding reading itself to be a significant problem. In establishing criteria for SDD, just as we hoped to avoid the risk of false positives (children who were poor readers for predominantly environmental reasons such as the absence of opportunity or poor teaching) so, too, did we wish to avoid false negatives—children who failed to come out as "dyslexic" by SRR criteria because they were adequate readers but who were clinically dyslexic in other ways.

We took the view, based on our clinical experience, that any ten-year old whose spelling was adequate could not be regarded as a "classic" case of dyslexia of the sort we were looking for; normal achievement at spelling was therefore a counterindicator to SDD, whatever the child's performance at reading. In contrast, a child who was severely underachieving at spelling was eligible for the SDD group regardless of his or her reading skills, given evidence that some SDD children could be adequate readers In addition, we stipulated that a child who was both a severe underachiever at reading *and* a moderate underachiever at spelling was also eligible to belong to the SDD group. This stipulation was made on the grounds that the two underachievements combined give rise to a different situation from that which would have held if either had occurred on its own. These criteria may seem complex, but they do no more than reflect the complexity of any specification based on clinical judgment. For ease of communication, children who were either severe underachievers at spelling or severe underachievers at reading *and* moderate underachievers at spelling will be referred to in what follows simply as "underachievers."

To eliminate the risk of false positive (children, who despite poor reading or spelling in relation to intelligence, did not seem to show the typical signs of SDD), we relied on three subtests from the Bangor Dyslexia Test (Left-Right, Months Forward, and Months Reversed), along with the Recall of Digits subtest from the British Ability Scales. These additional items, based originally on clinical experience, were used to supplement the existing information by supporting, or failing to support, the claim that the typical SDD pattern of difficulties was present. It has been argued by Miles (1993, p. 23) that a diagnosis of dyslexia is, in effect, a "bet." One is arguing on the basis of a limited number of signs that further manifestations will be forthcoming, and if it turns out they are not forthcoming, then the diagnosis was mistaken.

Because clinical experience had convinced us that there are a variety of dyslexia-related conditions, including so-called *formes frustes* (Critchley and Critchley 1978, Chapter 9), as well as individuals who, despite some literacy problems, did not present as typical cases of SDD, we created three categories of children with specific literacy difficulties in relation to their intelligence. These comprised: (1) those who on the basis of the supplementary items would probably, but not certainly, have displayed further signs of SDD had more data been available (the so-called "classic" cases); (2) those who were marginal; and (3) those who, as far as we could tell, did not appear to be showing typical signs of SDD. We shall refer to the first group as underachievers A, to the second as underachievers B, and to the third as underachievers C. On a probability basis, we hypothesized that the underachievers A group contained more SDD children than the underachievers B group, which in turn contained more SDD children than the underachievers C group.

Those who advocate the SDD concept are logically committed to showing that SDD children are different, not only from normal achievers but from other underachievers as well. The category of underachievers C was created so as to make possible this comparison; if no differences were found between underachievers A and underachievers C, the SDD concept would be weakened. This procedure meets the scientific requirement of generating a falsifiable hypothesis (compare Popper 1963).

The reason for creating the underachievers B group was different. It was inevitable in a survey on the scale of the British Births Survey—where the amount of information that could be collected about any one individual was limited—that there would be some children about whom a decision one way or the

other regarding SDD was problematic. Clearly, such children were not normal achievers; on the other hand, we did not wish to risk contamination of our data by including doubtful cases either in the underachievers A (SDD) group or in the underachievers C group. The creation of a separate group avoided both these risks.

It was also decided, after considerable thought, not to treat children as eligible for inclusion in the SDD group if there was any doubt about their level of intellectual functioning. This was done, not because we believed on *a priori* grounds that such children could not be dyslexic, but simply to avoid the unnecessary complications to which limited intellectual ability might give rise. Given the number of children available, it seemed desirable to choose a relatively high cutoff point rather than run the risk of contaminating our data with complications which could simply be the consequence of low intellectual ability. For this reason, it was decided to accept as eligible for inclusion in the SDD group only those children with a standard score of 90 or above on the combined results of the Similarities and Matrices tests.

The SDD children (underachievers A) were then defined as those children of adequate intellectual ability who satisfied *both* the criteria for underachievement specified above *and* had at least two positive indicators or at least three zeros on the supplementary items. (Further specification of what this means is found in Appendix II). Underachievers B (the buffer group) were defined as those who, on the supplementary items, had either a positive indicator and a zero or two zeros, whereas underachievers C were defined as those who had at most a single positive indicator or a single zero. It should be noted that the three groups all satisfied the same criteria for underachievement and that they differed only with respect to their performance on the supplementary items.

Our procedure was not intended to provide a method for determining the overall prevalence of SDD. As was indicated above, the intention was to specify criteria by which the clearest and most obvious cases of SDD could be picked out and to provide two further groups for comparison.

The above description of our procedure emphasizes in an interesting way the difference between a specification based on clinical judgment and one based simply on a statistical cutoff point. If one is trying to identify a given condition, it may well be that many individuals outside a particular statistical cutoff point do in fact exemplify the condition; still, the cutoff point

does not *define* the condition. Therefore, in the present case, a cutoff point which separated severe underachievers at word recognition from other children might well, if used on its own, have captured a significant number of SDD children. However, it still would not have provided a definition of SDD.

Another interesting feature of a clinical judgment is the use of concepts such as "either–or", "unless", and "both–and" to reflect how a diagnosis is made. Typically, condition A is present if *some* of symptoms V, W, X, Y, and Z are present, or if *both* symptom Y *and* symptom Z are present. In some cases it may be necessary to add the proviso "*unless* symptom M is present" in which case symptom M is described as a "counterindicator." The diagnosis as a whole is made on the basis of a coherent *pattern* of symptoms, and the presence of a counterindicator may indicate that the "fit" to this pattern is less than adequate.

In the present study, we used both disjunctive concepts (SDD entails underachievement at *either* spelling *or* word recognition) and conjunctive concepts (SDD entails *both* a particular level of underachievement *and* sufficient positive indicators on the supplementary items); normal achievement at spelling was treated as a counterindicator. In contrast, the SRR concept depends on a statistical cut-off point, and it is unambiguous whether or not an individual belongs to a particular group. Although the tidiness of the SRR classification may find favor with those who operate primarily in statistical terms, the SDD concept appeals to those of us who have wrestled with the problems and complexities of clinical diagnosis. We suspect that lumping everything together that falls on one side of a statistical boundary is unlikely, on its own, to point to a worthwhile taxonomy. What we have used in the present study is information based on statistical boundaries (scores on the word reading and spelling residuals) *combined with* information based on the results of the supplementary items derived from clinical judgment. We believe that the combination of the two methods provides a more powerful research tool than either method alone.

The present procedure differed from a simple discrepancy-based approach as follows:

- tests of intelligence were chosen which, we believed, would not put SDD children at a disadvantage (Thomson 1982);
- spelling scores were used as well as reading scores;
- single word reading was tested rather than reading comprehension; and

- clinically-based supplementary items from the Bangor Dyslexia Test, and the Recall of Digits from the British Ability Scales, were included as further evidence for the presence or absence of SDD.

RESULTS AND DISCUSSION

Data were available on 11,804 children, 5,995 boys and 5,809 girls.[5] For reasons indicated above, it was decided to divide the children into four subgroups: the three groups of underachievers, defined earlier, and the rest of the cohort. Table I gives the gender ratios (adjusted to take into account the preponderance of boys in the cohort) for each subgroup. It is clear from this table that the underachievers A (SDD) group contained many more boys than girls, by a ratio of 4.51 to 1. Moreover, since the gender ratios are different in the three groups, the decision to define the SDD children as a distinctive group receives some measure of support.

TABLE I. GENDER RATIOS FOR THE DIFFERENT SUBGROUPS

	Total *n*	Male	Female	Ratio of boys to girls	Ratio adjusted for slight preponderance of boys in total cohort
Underachievers A (SDD)	269	223	46	4.85	4.51
Underachievers B (buffer)	221	163	58	2.81	2.72
Underachievers C (others)	417	243	174	1.40	1.31
Rest of Cohort	10,897	5,366	5,531	0.97	0.94
Total Cohort	11,804	5,995	5,809	1.03	

[5] The full cohort for whom educational data were available comprised 12,905 children, 6,685 boys (51.8%) and 6,220 girls (48.2%). Inevitably, in a survey of this magnitude, data sets were sometimes incomplete; for 1,101 cases (8.53 % of the total sample) missing data made it impossible either to confirm or exclude SDD. These 1,101 cases were made up of 690 boys and 411 girls. Given that our 269 SDD children constituted 2.28% of the total sample, it is possible that there might have been about 25 additional SDD children (2.28% of 1,101) had full data sets been available. Given the excess of boys in the missing data, it seems unlikely that among the hypothesized SDD children there would have been an excess of girls. Even on this unlikely hypothesis, however, the overall gender ratio among the SDD children would not have been seriously affected.

Before we proceed further, it is necessary to consider whether the predominance of boys in the SDD group could have been a statistical artifact, one which had arisen not for any reason connected with dyslexia, but because there was an imbalance in gender ratios on the four supplementary items.

Table II shows the total numbers and gender ratios of those who came out plus, zero, and minus on each of the four supplementary items. At first glance, this result seems damaging to our thesis because on Months Forward, 2,430 boys out of a total of 6,482 (37.60%) earned a plus or a zero, compared to 932 girls out of a total of 6,060 (15.38%). It was possible, therefore, that the apparent strong gender bias derived from our choice of a supplementary item, independent of a child's status in relation to dyslexia. Moreover, since the selection procedure for underachievers C guaranteed that most of this group would be successful on Months Forward, it is possible that the relatively small preponderance of boys in group C was an artifact of that single item.

To find out if this was indeed the case, we calculated the gender ratio among the SDD children, this time relying on the other three supplementary items. Because there were four items in all (call them ABCD), there were four possible estimates of gender ratio when any three of them were used in combination (ABC, ABD, ACD, BCD). The outcome of this analysis is shown in table III. Clearly, even when the Months Forward item is discounted, the 4:1 boy to girl ratio still holds up; any three supplementary items out of the four generate a similar gender ratio.

TABLE II. NUMBERS OF BOYS AND GIRLS SCORING DYSLEXIA POSITIVE, DYSLEXIA ZERO, AND DYSLEXIA MINUS ON THE FOUR SUPPLEMENTARY ITEMS

	Dyslexia Positive			Dyslexia Zero			Dyslexia Negative		
	Boys	Girls	Ratio	Boys	Girls	Ratio	Boys	Girls	Ratio
Recall of Digits	1,903	1,858	1.24	2,356	2,294	1.03	1,958	1,965	1.00
Left-Right	756	652	1.1	688	1758	1.16	4,990	4,770	1.05
Months Forward	788	183	4.31	1,642	749	2.19	4,032	5,128	0.78
Months Reversed	1,078	537	2.01	2,063	1,512	1.36	3,110	3,968	0.78

Note. Use has been made in the above table of all available information on the supplementary items, including those cases where complete data sets were not available; for this reason the row totals add up to more than 11,804.

TABLE III. GENDER RATIOS WHEN EACH OF THE FOUR SUPPLEMENTARY ITEMS* IS EXCLUDED IN TURN

Combination	No. picked	No. of boys	No. of girls	Ratio	Ratio adjusted for slight preponderance of boys in total cohort
A B C	65	56	9	6.22	6.00
A B D	88	73	15	4.87	4.54
A C D	183	156	27	5.78	5.42
B C D	194	164	30	5.47	5.10
ABCD	269	223	46	4.85	4.51

* A = Recall of Digits, B = Left-Right, C = Months Forward, D = Months Reversed

A FURTHER ANALYSIS, USING SRR CRITERIA

For the next analysis, we looked at the gender ratio when the supplementary items were excluded. One of the things that concerned us when we first read the papers by Shaywitz et al. (1990), Wadsworth et al. (1992), and Lubs et al. (1993) was that their results were at variance, not only with the earlier literature but also with ordinary experience. For example, when we spoke about this new evidence to head teachers of schools for dyslexic children, they found it extremely hard to credit. In their initial paper, Shaywitz et al. (1990) drew a distinction between research-identified and school-identified children. They reported that only in the case of school-identified children was there any significant imbalance in gender ratio. Their suggested explanation was that teachers perceived boys as being more disruptive than girls, and were therefore more likely to refer them as having special problems (p. 1002). The preponderance of boys reported in the literature could therefore be explained in terms of selection bias.

This interpretation is hard to square with data from Miles (1993; see especially p. 25); of the 223 individuals referred to him and selected as classic cases of dyslexia, 182 were male and 41 female (ratio 4.4:1). This was indeed a clinic population, which means that referral bias cannot be categorically excluded. If the referral bias hypothesis is right, however one would have to assume that boys are much more disruptive than girls not only at school but also in the home. We find it surprising that our previous detailed documentation (Miles 1993) has revealed so much about the dyslexic pattern of difficulties and so little about disruptiveness. We think it is possible that many of the children referred through the school system in the Shaywitz et al. study were recognized by

their teachers as having what in this paper we have called SDD, and therefore in need of special help.

Thus our next step was to take special note of the procedures adopted by Shaywitz et al. (1990) and consider possible ways in which their procedures differed from ours. What we found was that they had relied only on reading and intelligence measures, and had excluded spelling tests and anything corresponding to our supplementary items. We thought it would be interesting to carry out a further analysis of our own data using SRR as the criterion for dyslexia rather than SDD.

We had available to us, as part of the British Births Survey, a reading test which we did not use in picking out children with SDD. This was the Edinburgh Reading Test primarily a test of reading comprehension. We did not use it because clinical experience told us that SRR children could sometimes be strong at comprehension and that accurate attention to detail was less important in text reading than in a test of single word reading. For present purposes, however, where a measure of poor reading in relation to intelligence was needed independently of any clinical experience we might have of the field, we decided that the Edinburgh Reading Test was entirely suitable and would form a good basis for comparing the SRR concept with the SDD concept. In particular, we wanted to know if the gender ratio would be any different on the two definitions.

To provide residuals on the Edinburgh Reading Test, we again measured intelligence by taking the combined score on the Similarities and Matrices tests. A regression equation was calculated in the same way as before, and those whose residuals were more than 1.5 standard deviations below prediction were classified as severe underachievers. The numbers of boys and girls who satisfied this criterion are given in table IV.

It can be seen from this table that 494 children came out as severe underachievers, of whom 314 were boys and 180 were girls (adjusted ratio 1.63:1). Clearly, if dyslexia is defined in terms of SRR, it is not the case that there are many more affected boys than girls. What is also clear is that conflicting re-

TABLE IV. GENDER RATIO OF SEVERE UNDERACHIEVERS WHEN DYSLEXIA IS IDENTIFIED IN TERMS OF SRR (EDINBURGH READING TEST)

Total	No. of boys	No. of girls	Ratio	Ratio adjusted for slight preponderance of boys in total cohort
494	314	180	1.74	1.63

ports in the literature have arisen because different criteria for dyslexia were being used.

DISCUSSION

The purpose of this paper was to define operationally what we believe has been meant traditionally by the term dyslexia (SDD) and to distinguish it from reading disability/specific reading retardation. When SDD is defined using clinically derived criteria specifying low spelling (and/or reading) together with clinically significant weaknesses on the Bangor Dyslexia Test, gender ratios were 4.5 to 1. In contrast, when criteria for SRR (involving only a significant weakness in reading in relation to IQ) were applied to the very same sample, gender ratios were much closer to 1:1.

One objection to the SDD criterion refers to a potential gender bias in one of the Bangor items. We ruled this out as unable to explain the extreme preponderance of boys. A second, and more basic, objection to our procedure for defining SDD concerns the possibility that the choice of items in the Bangor Dyslexia Test is itself affected by an unwarranted reliance on clinical judgment without proper scientific justification. The great drawback to decisions based on clinical judgment ("I know one when I see one") is that they involve the risk of perpetuating a misleading stereotype. For example, there is reason to suspect that some clinical psychologists may have misled themselves and others by putting forward, with unjustifiable confidence, somewhat speculative interpretations of responses to the Rorschach inkblot cards. The possibility needs therefore to be faced that the concept of SDD, as operationalized by the Bangor Dyslexia Test, is open to the same objection.

Let us press the argument further. Stereotypes, it might be said, tend to become confirmed as descriptions of the alleged condition appear in the popular press. As a result, people recognize the said condition as applying to their children, their pupils, or themselves. They then ask to be assessed by "experts" who regard the referrals as further evidence that their views are correct, thus reinforcing the stereotype! Could it be that the choice of items in the Bangor Dyslexia Test was itself influenced by this misleading stereotype?

If this objection is valid it would apply, of course, both to the Bangor Dyslexia Test in its full version and to the items selected from it which were used in the present study. In what follows we shall refer to evidence from both sources.

The first point to make is that the SDD concept, although not a new one in terms of the clinical experience of the early pioneers, has not been operationalized previously. Because it is impossible to validate our measure of SDD without *other* measures of SDD to compare it to, arguments in support of the SDD concept have to be of a different kind. Our aim therefore is not to demonstrate conclusively that the SDD concept provides a valid taxonomy, but instead to cite an accumulation of research findings on the Bangor Dyslexia Test which in the absence of the SDD concept would be difficult to explain away.

Now it should be noted that acceptance by the scientific community of a particular taxonomy does not normally depend on a single experiment or on one kind of evidence; rather, advances are achieved when there are interlocking pieces of evidence that cannot otherwise easily be explained away. Not only do all the pieces of evidence demand explanation in their own right; more importantly, when they are taken in conjunction a much stronger structure emerges, while at the same time alternative explanations become progressively more uncomfortable.

The first relevant evidence derives from data from the British Births Survey published by Miles (1993) showing that items from the Bangor Dyslexia Test accounted for a sizable proportion of the variance on word recognition and other academic measures of spelling, mathematics, and pictorial comprehension. Sample tables shown in appendix III illustrate the significance of the Bangor items even when controlling for intelligence. Clearly, these "dyslexia indicators" are associated with academic success apart from their association with general intelligence. In fact, in a separate analysis of the same data set, Miles, Haslum, and Wheeler (1997) found that SDD children differ from normal achievers *and* the underachievers C group on some (but not all) of a 72-item mathematics test.

Additional support for the utility of the Bangor Dyslexia Test derives from evidence that children believed to be dyslexic (in the SDD sense) on clinical grounds scored more pluses on the Bangor Test (positive indicators of dyslexia) than did suitably matched controls (Miles 1993, pp. 56–57). Similarly, Oviedo (1996), when she translated the Bangor Dyslexia Test into two Spanish languages, Castilian and Galician, found a difference in the number of positive indicators, not only between children diagnosed as dyslexic and normal readers but (to a lesser extent, although still at a statistically significant level) between those diagnosed as dyslexic and poor readers believed *not to be* dyslexic.

It is important to note that poor performance on the Bangor items is not a simple function of reading level. For example, children selected on the basis of poor spelling scored more positive indicators on the Bangor Dyslexia Test than did younger children matched for spelling age (Miles 1993, Chapter 27). Similar results were found in Greece (Miles 1993, Chapter 28); and there was also some supporting evidence from Germany and Japan (Miles 1993, Chapters 29 and 30).[6]

The Bangor Dyslexia Test also has some intriguing distributional attributes. For example, in an early analysis of the results from the British Births Survey (Miles and Haslum 1986) when we attempted to pick out SDD children by means of a dyslexia index that included the supplementary items used in the present study, there was unambiguous evidence of an excess of children at the dyslexia end of the distribution. If allegedly positive indicators of SDD occur simply in accordance with normal variation, their frequencies will conform to the Poisson distribution. Interestingly, Miles and Haslum (1986) did find a Poisson distribution among discrepantly *good* readers and spellers, confirming the widely held view that indicators of SDD occur in many people from time to time on a random basis; however, among the discrepantly *poor* readers and spellers, there was significant departure from the Poisson distribution.

The final evidence in support of the Bangor Dyslexia Test is theoretical plausibility. It is now recognized that a central feature in dyslexia (however defined) is a weakness at the phonological level; and if the items in the Bangor Dyslexia Test are examined from this point of view (Miles 1993, Chapter 25), it seems clear they are precisely the kinds of items which those with a weakness at the phonological level might find difficult. Although a clinical hunch was the reason for the choice of these items in the first place, there is now a degree of theoretical justification for them which did not exist when the test was first published.

At a more speculative level, there is now good reason for supposing that SDD may be associated with minor malfunctioning of the cerebellum (Nicolson, Fawcett, and Dean 1995; Nicolson et al. 1996). If, as suggested by Thach (1996), one of the functions of the cerebellum is to make possible the use of motor sequences as an aid to memorizing, persons with minor cerebel-

[6] The co-authors of Chapter 26 were T. R. Miles, M. N. Haslum, and T. J. Wheeler; of Chapter 27, T. R. Miles and S. A. Turner Ellis; of Chapter 28, T. R. Miles and Andriana Kasviki; of Chapter 29, T. R. Miles and Claudia de Wall; and of Chapter 30, T. R. Miles, Jun Yamada, and Adam Banks.

lar deficiencies should perform such sequences relatively less efficiently. Thach makes his point as follows:

> Beginning with babbling in infancy, we proceed through "rote learning" of nursery rhymes, nonsense poems, and jingles without necessarily understanding them. . . . We can listen to what we say in order to get at what we otherwise can't remember. For example, "Thirty days hath September . . . " allows us to remember how many days there are in each month. . . . One can suggest that recitation of the alphabet, multiplication tables, are similar (p. 429).

What Thach says about recitation of the alphabet and about tables also could apply to the memorization of the months of the year, providing an intriguing theoretical justification for why the clinically derived Months Forward item may be a useful indicator of SDD.[7]

It does not, of course, follow from these considerations that the claims of those researchers who have made poor reading the central concept of dyslexia are therefore discredited. It is more than likely that their selection procedures picked up many children who were both poor readers *and* showed other signs of SDD, particularly in those studies where the participants were chosen from prosperous communities where environmental deprivation played only a minor part. The objection to their procedure is not that it is inherently flawed but that it leads to the presence of an unnecessary amount of "noise." It can still be claimed that the research findings contribute to a powerful taxonomy even though this can more usefully come under the general explanatory principle of SDD. One can therefore say that SDD has a biological basis (Galaburda and Livingstone 1993), that it is sometimes inherited (Pennington 1991), and that it is often the consequence of difficulties at the phonological level (Catts 1989; Rack 1994). Certain researchers (Tallal, Miller, and Fitch 1993; Merzenich et al. 1996) also believe that some of the clinical manifestations of dyslexia are the consequence of a biologically based difficulty in responding accurately to auditory input presented at very rapid speeds, although some of these claims have been called into question (Studdert-Kennedy et al. 1994–1995). These are all live research issues which are interrelated through the SDD concept.

[7] Recitation of multiplication tables is one of the items in the Bangor Dyslexia Test, although it was not used in the British Births Study. In the Bangor-Hiroshima Dyslexia Test (Miles 1993, Chapter 30, and pp. 259–60), which is modeled closely on the original Bangor Test, one of the items is to say the alphabet (syllabary) backwards.

Without this concept, however, there is no logical justification for making such a connection. Those who define dyslexia in terms of SRR are forced to say that some poor readers *also* display these other manifestations, but unless one goes beyond the SRR concept there is no logical commitment to look for an overall explanation.

A view similar to that of the present authors was put forward by Scarborough (1991), who wrote:

> Instead of casting the preschool characteristics of dyslexic children as "precursors" and the reading problems of these children as "outcome", it might be more helpful to view both as successive, observable symptoms of the same condition. . . . While the educational goal may be to explain reading difficulty for its own sake, the neuropsychological goal is to define the nature of the fundamental difficulty that manifests itself most evidently, but not solely, as underachievement in reading (p. 38-39).

We would even go further, and query Scarborough's use of the expression "most evidently." An alternative is to say that lateness in learning to read is a fairly common manifestation (although not an invariable one) of this underlying condition, and we would wish to argue that unless the underlying condition is present (whatever it may be) the term dyslexia should not be used. Those who assume that dyslexia can be equated by definition with poor reading are depriving themselves of a taxonomy which appears, in the light of the latest research evidence, to be one of considerable power. (For similar views see also Nicolson et al. 1996; Frith 1997).

It is true, of course, that the concept of SRR has the merit of simplicity in contrast to the concept of SDD, since it requires no elaborate operationalization of clinical judgments. Arguably, however, it may be more appropriate to view "reading" as a "starter" concept; and in that case, like "memory", "intelligence", and "learning", it not only broadly delineates a research area but also covers a "mixed bag" of somewhat diverse phenomena.

On the other hand, if the SDD criteria are correct, the procedure adopted by the SRR researchers has effectively buried the SDD children in a much wider population of children who, at a given time, were underachieving at reading. Although it seems that he may have been ignored, Critchley (1970) warned against this risk over a quarter of a century ago:

> Throughout the world, instances of developmental dyslexia tend to be submerged within the larger population of bad readers, and so their specificity may escape detection. . . . To what extent these groupings represent a melange of the educationally inadequate, the intellectually deficient, the emotionally disturbed, the infirm of purpose, and the genuine dyslexics, has never been determined (p. 94-95).

In further papers (1992, 1994) Shaywitz et al. refer to the studies of Rutter, Tizard, and Whitmore (1970) and of Rutter and Yule (1975). The following passage merits detailed discussion:

> Traditionally dyslexia has been viewed as a specific categorical entity that affects a small, circumscribed group of children and that is invariable over time. Classically, this group of individuals, often referred to as having specific reading retardation (SRR) (Rutter, Tizard, and Whitmore 1970), has been envisioned as primarily male and as qualitatively distinct from other poor readers (Shaywitz et al. 1994, p. 13).

We question, however, whether the authors' subdivision into categorical and dimensional models does justice to the complexity of the situation. Certainly some concepts are *purely* categorical: one cannot, for instance, have a mild touch of pregnancy. There are many others, however, where within a broad diagnostic label there is considerable diversity. If, therefore, it is asked whether dyslexia is a categorical or a dimensional concept, one may perhaps query whether it has to be unambiguously one or the other. As was pointed out earlier, the dyslexics in table I (underachievers A) were characterized as those about whose dyslexia there was little doubt.

It should also be pointed out that Rutter and his colleagues took particular care *not* to use the word dyslexia. They chose instead the expression specific reading retardation precisely because they did not wish to commit themselves to the theoretical superstructure which the word dyslexia seemed to imply.

If the two concepts, dyslexia and specific reading retardation (SDD and SRR) meant the same thing like, for example, rubella and German measles, the matter would have been unimportant: a claim about the one would in that case have also been a claim about the other. As things are, however, there is a problem of communication. Like Rutter and his colleagues, Shaywitz et al. picked out children who were poor readers in relation to their intelligence; unlike them, however, they then pro-

ceeded to call such children dyslexic. The fact that Rutter and Yule obtained different results, e.g. more boys than girls, and relative stability of diagnosis, is, of course, an interesting phenomenon in its own right. A possible explanation is that the Isle of Wight, where their study took place, is a relatively prosperous area where one might expect a relatively larger proportion of SDD children in comparison with children who were underachieving through lack of educational opportunity. This suggestion, however, cannot be more than speculative.

Had Shaywitz et al. (1992) treated SDD and SRR as different concepts, they would then have said, not "that dyslexia may represent the lower tail of a normal distribution of reading ability" (p. 145), but that certain statistical procedures show this to be true of SRR. They also say (1992) that "only 7 of the 25 children (28 percent) classified as having dyslexia in grade 1 would also be classified as having dyslexia in grade 3" (p. 145). It makes sense that there should be this instability of diagnosis in the case of children with SRR, since reading is clearly a skill that can be taught. There is ample evidence, however, from both sides of the Atlantic, both experimental (Miles 1986) and personal (Simpson 1980; Hampshire 1981; Fenwick Stuart 1988; Ganschow, Lloyd-Jones, and Miles 1994; Gilroy and Miles 1995; Rawson 1995), that if the word dyslexia is given its traditional sense, some of the difficulties experienced by dyslexics persist into adulthood. The Shaywitz et al. studies do nothing to refute this. Moreover, if such people can read adequately it would be necessary for those who equate dyslexia with poor reading to refer to them as "compensated" dyslexics; this could have the unfortunate consequence of their current needs being overlooked.

CONCLUDING REMARKS

The main purpose of this paper was to report on the gender ratio in dyslexia. In the course of writing the paper, however, wider theoretical issues emerged, and one particularly far-reaching source of apparent disagreement was revealed. The claim by Shaywitz et al. that there are nearly as many dyslexic girls as boys needs to be considered in the context of their other claims, in particular the claims that full stability of diagnosis is lacking in dyslexia and that dyslexics simply represent one tail of a normal distribution of reading ability. If, as commonly happens, researchers pick out children who have difficulty with reading in relation to their intelligence, and then regard themselves as enti-

tled to make statements about dyslexia in the traditional sense, the world at large will assume that certain things are true of dyslexia in the traditional sense which, in fact, are true only of specific reading retardation.

The words "in the traditional sense" are important here. Those who speak of "dyslexics" are implicitly claiming to be part of a tradition which began in Britain with Morgan (1896) and Hinshelwood (1917), was significantly advanced in the United States by Orton (1937/1989), and was later taken up in Scandinavia by Hallgren (1950), Hermann (1959), and in Britain by Critchley (1970). Although these writers sometimes appear to place what we feel is an undue emphasis on poor reading, it is clear that poor reading *simpliciter* was not their main interest. For example, the paper by Morgan contains an interesting list of spelling errors, and Hinshelwood makes clear that he is talking about "a pathological condition" (1917, p. 40), whereas, there need be nothing pathological about being a poor reader. Orton's book refers specifically to "reading, *writing and speech* problems" (authors' italics); Hallgren, who speaks, like Morgan and Hinshelwood, of "congenital word blindness"—and gives the alternative description "specific dyslexia"—clearly has SDD children in mind, while Critchley (1981) writes:

> The etymology of the term "dyslexia" expresses admirably a difficulty–not in reading–but in the use of words, how they are identified, what they signify, how they are handled in combination, how they are pronounced, and how they are spelt. . . . The term "specific reading retardation" is . . . not appropriate as it indicates an isolated symptom, whereas developmental dyslexia is a complex syndrome (p. 2).

We therefore ask that the word dyslexia be used only in its traditional sense, to refer to a family of lifelong manifestations that show themselves in many ways other than poor reading. We would even argue that the criterion of poor reading typically applies only between the ages of about five and fourteen years, because one cannot be a poor reader below the age of five years, and by age fourteen, many who formerly had reading problems can read more or less adequately. It would make for better communication if those who wish to limit their studies to reading did not use the word dyslexia at all.

Finally, we stress that the issue is not simply one of avoiding misunderstanding. The reason for investigating SDD as opposed to SRR is that the concept of SDD represents a more powerful

taxonomy, one which links together converging evidence from a number of different research areas. Identification of dyslexia with poor reading or specific reading retardation neglects this taxonomy and is, therefore, in our view, a hindrance to the advancement of scientific knowledge.

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APPENDIX I.

Word Recognition and Spelling Tests Used in the British Births Survey

a. Diagnostic Reading

Please ask the child to read out each of the words on the list at the end of this paragraph. The words should be read *from left to right* in each line. As the child reads each word, please note incorrect pronunciation (or refusal to attempt the word) on the appropriate list in the Educational Score Form.

PLAY	SHARP	LIST	OLD	JUMPING
BEFORE	SOON	OPEN	SLY	GROUND
CHILDREN	DITCH	MOUTH	AIR	SPEAKING
LOW	EVERYONE	MISCHIEF	FRIENDLY	BECAUSE
STRANGE	FAREWELL	MEADOW	FRIGHTENED	TOWARDS
BEAUTY	ADVENTURE	ALTOGETHER	THISTLE	AUTUMN
GRACIOUS	OCEAN	QUARRELSOME	NEIGHBOURHOOD	JEALOUSY
DELICIOUS	SOVEREIGN	MANUFACTURE	IDLENESS	POPULATION
ACQUAINTANCE	PALEST	CEREMONY	MONUMENTAL	ACKNOWLEDGE
THREATEN	BURIAL	LEAGUE	NEVERTHELESS	TRIUMPHANT
ROGUE	RUINOUS	DENY	ORIGINAL	CONSEQUENCES
REVERENCE	CHEQUE	PYRAMID	VEHICLE	EMPHASISE
LIEUTENANT	BENEFICIAL	PIETY	ENDEAVOUR	SUSCEPTIBLE
SACRIFICIAL	ANTICIPATE	IDIOTIC	AREA	HEROIC
DIAMETER	FACILITY	CYNICAL	ANALYSIS	PICTURESQUE
SOLICITOR	INACCURACY	STRATAGEM	PERSUASIVE	MANOEUVRES
PREFERENCE	TYRANNY	CATASTROPHE	OPAQUE	DECISIVE
MISCELLANEOUS	RECIPE	PRECIPITOUS	PNEUMONIA	CALIBRE
MAUSOLEUM	OCCIPITAL	FACETIOUS	TSETSE	NAUSEA
RHETORIC	UNANIMITY	HEINOUS	FORTUITOUS	DESULTORY

b. Writing and Spelling:

Please dictate the following to the child, at a speed suited to the child's pace of writing. If the child cannot write a word and asks how to spell it, say: "Just try to write it as best you can", and repeat the sentence containing the problem word. Do not repeat a particular sentence more than once. However, if the child asks for a repetition of the imaginary words in the middle of the passage, those words may be repeated twice. Please note the time taken by the child to complete the writing of the passage, in the appropriate space on the Educational Score Form.

I often visited my aunt. She lived in a magnificent house opposite the gallery. I remember her splendid purple curtains. She wrote poetry. The problem was nobody could understand it. Her latest poems had words like prunty, slimber, grondel, blomp. I wanted to laugh but I had to pretend to like them. However, I really like the special refreshment. There was blue juice, cake and biscuits. When I left, my stomach was full and I was happy and contented.

APPENDIX II.

Three Items from the Bangor Dyslexia Test (Miles 1982, 1997)

Note. These items constituted three of the four supplementary items as described in the main text. The fourth supplementary item was the Recall of Digits from the British Ability Scales (Elliott et al. 1979/1983).

The following written instructions were given to the teachers in the British Births Survey:

Naming Body Parts: The Left-Right Test
Seat the child at a table opposite you. Read each instruction clearly to the child, taking care to look straight ahead. Do not look at his/her or your hands. For item 3 onward, put both your hands on the table, palms down, fingers pointing toward the child.

Please tick the appropriate boxes on Page 9 of the Educational Score Form for the child and the observer. If the child corrects his/her response, please record the final response.

1. ***Show me your right hand.***
2. ***Show me your left ear.***
3. ***Which is MY right hand?*** (Put both hands on the table.)
4. ***Touch my left hand with your right hand.***
5. ***Point to my right ear with your left hand.***
6. ***Touch my right hand with your right hand.***
7. ***Point to my left ear with your right hand.***
8. ***Touch my right hand with your right hand.***
9. ***Touch my left hand with your left hand.***

Additional information about whether the child corrects his initial response, asks for the question again, or echoes the question would be most helpful.

Sequential Recall—Months of the Year
Please ask the child to say the months of the year in order and record the response on Page 9 of the Educational Score Form.

1. ***Say the months of the year.*** (Record response on the Educational Score Form.)

2. ***Now say them backwards.*** (Record response on the Educational Score Form.)

Write down the initial letter of each month as it is said, indicate long pauses with dots. For example, if a child pauses after August and inverts September and October but then corrects them, the entry would read:

J F M A M J J A . . . O S, no S O N D

Please record all corrections. Also record any queries about the importance of order, e.g., "Do I have to say them in order?"

APPENDIX II. (continued)

Instructions for scoring, given in the manual for the Bangor Dyslexia Test, are as follows:

Left-right (body parts)

Score as plus:

1. Two errors or more
2. Consistent mirror image of correct answer
3. Subject turns in his seat (real or imagined)

Score as zero:

1. Report of earlier difficulty over left and right and/or report of special strategy (referring to watch, scar, "the hand I write with", etc.)
2. Hesitation in working out the answer in at least two items
3. Any two examples of echoing the question or asking for it to be repeated (e.g., "My left with your right, was it?")
4. One error

Months Forward

Score as plus:

1. Any two or more omissions
2. Any two or more inversions (for example, "October, September" for "September, October")
3. Any uncertainty where to start
4. Any query about the importance of order (for example, "Do I have to say them in order?")

Score as zero:

1. Any two corrections
2. Any one omission (for example, leaving out September)
3. Any one inversion
4. Any report of earlier difficulty or special tuition

Months Reversed

Score as plus:

1. Any two or more omissions
2. Any two or more inversions

Score as zero:

1. Any two corrections
2. Any special strategies, (for example, saying the months forward under his breath)
3. Any one omission
4. Any one inversion

Note that in both months forward and months reversed a single corrected error is scored as minus.

APPENDIX III.

Extracts from Tables 26.3 and 26.4 of *Dyslexia: The Pattern of Difficulties* (Miles 1993).

These two tables show the relationship between (supposed) dyslexia indicators and educational performance (table 26.3) and educational underachievement (table 26.4). The technique used was that of stepwise regression (for an account of this technique see Norusis 1983). The first column in each case shows the regression coefficients. These indicate how much the word recognition test score (in this example) changes for unit increase in the variables in the equation. Thus it can be seen from the analysis that there is a much greater change associated with Recall of Digits and Months Reversed than there is for the others. Column 2 shows that these two items were accounting in conjunction for 13.87% of the variance. It can also be seen that whereas the gender of the child has an influence on word recognition performance (a positive value indicating that girls had higher scores than boys), it is tiny compared with the influence of the (supposed) dyslexia indicators. Further analysis (not given here) showed similar effects for spelling, spelling residuals, the Edinburgh Reading test, and a mathematics test.

Extracts from Table 26.3

	Regression coefficient	Explained variance(%)	Change (%) in explained variance
Word recognition test			
Recall of Digits	**–0.29**	**8.53**	**8.53***
Months Reversed	**–0.27**	**13.89**	**5.34***
Left-Right test	**–0.15**	**14.99**	**1.11***
Months Forwards	**–0.21**	**15.93**	**0.96***
Gender	**0.02**	**15.99**	**0.06+**

A further analysis was then carried out using the word recognition and spelling residuals, i.e. removing the influence of intelligence. The results were as follows:

Extracts from Table 26.4

	Regression coefficient	Explained variance(%)	Change (%) in explained variance
Word recognition test			
Months Reversed	**–0.18**	**3.08**	**3.08***
Recall of Digits	**–0.17**	**5.32**	**2.24***
Months Forwards	**–0.16**	**6.12**	**0.80***
Left-Right test	**–0.05**	**6.16**	**0.04***

*$p<0.001$

+$p<0.005$