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LASS 8-11 Guidelines on interpretation of results

Types of scores in LASS 8-11

LASS 8-11 results on each individual test are available in six different forms:

- Raw score
- Projected score
- Centile score
- Z-score (standard deviation units)
- Age equivalent
- Discrepancy

Each of these is described in the following sections and it is important that teachers understand these. Of these different types of scores, centile scores will generally be most useful for teachers, although educational and clinical psychologists may prefer to work with z-scores.

Centile and standard deviation scores are shown in graphical form as bar charts on-screen and both these and the data pages can be printed out if desired. The *Graphical Profile* automatically charts the individual pupil's performance against those of the norm referenced group, which is based on the pupil's age in the following bands: 8:0 – 8:11; 9:0 – 9:11; 10:0 – 10:11; 11:0 – 11:11. If required the raw scores and projected scores may be accessed via the on-screen *Data Tables* for each LASS 8-11 test, which also show the means and standard deviations for the population norms of each test, together with the overall time the child took to complete that test in minutes and seconds. Finally, the *Summary Table* shows all the test results for that child (except raw scores), including date of test, age when tested, age equivalents and discrepancies.

Raw scores and projected scores

Raw scores are the number of items the pupil got correct. As the tests on LASS 8-11 are mostly adaptive, this information is not very helpful. Two children may have passed the same number of items, but one child may have done items that are more difficult than those tackled by the other child, so they will not be at the same level of performance. For this reason we need scores that reflect item difficulty, and these are called projected scores. Projected scores are scores derived from raw scores by an algorithm based on the item analysis carried out as part of the standardisation. Projected scores represent the score the pupil is statistically predicted to obtain if the test had been completed in conventional (as opposed to adaptive) format. Unlike centile scores and z-scores, projected scores are not corrected for age. Projected scores (not raw scores) should be used when calculating age equivalents.

Centile scores

A centile score (sometimes referred to as a 'percentile score') should not be confused with percent correct. It reflects a pupil's ability on any given test on a scale of 1 to 99 in comparison with other pupils in the reference group (i.e. the norm group or the same age group). Hence the average pupil will obtain centile scores in the middle range (e.g. in the range 35 – 65), whilst an above-average pupil will have centile scores higher than this, and the below-average pupil will have centile scores lower than this. For example, a pupil with a centile score of 5 will be just inside the bottom 5% of pupils for that particular ability, and a pupil with a centile score of 95 will be just inside the top 5% of pupils for that particular ability.

z-scores

It is not essential for users to understand the statistical principles behind z-scores, and readers who do not have a particular interest in this may wish to skip this section. The following outline is necessarily brief: it is not intended to be a comprehensive tutorial on the subject. Readers who desire to find out more about these ideas are recommended to consult any standard textbook of statistics.

A z-score (also known as a standard deviation unit) is a statistic based on a normal distribution of scores. Most human characteristics are distributed in a normal[1] (or approximately normal) fashion (i.e. a bell shaped curve, sometimes called a 'Gaussian curve'), in which individuals cluster towards the mean (or average) and become less common as one approaches the extremes (or 'tails') of the distribution. The proportion of individuals that will fall in any given portion of a normal distribution can be calculated. For example, two-thirds (66%) of individuals will lie between + or – one standard deviation of the mean, while slightly less than 3% will fall below 2 standard deviations of the mean.

An advantage of z-scores is that they facilitate analysis of the *extremeness* of individual scores or of differences between scores, which are not apparent when using the centile score format. For example, consider the following results:

Centile scores	Reasoning	Sentence Reading	Difference
Pupil 1	60	40	20
Pupil 2	90	70	20

In both cases, the pupils' sentence reading performance is 20 centile points below their reasoning scores. Which (if any) of these is a significant difference, i.e. one that we should take notice of when interpreting results? On centile score difference, both appear to be the identical, so this format does not help us. The same results in equivalent z-score format reveal a different story:

z-scores	Reasoning	Sentence Reading	Difference
Pupil 1	0.25	– 0.25	0.5
Pupil 2	1.6	0.6	1.0

[1] The term 'normal' here is being used in its statistical sense.

Now it is apparent that the difference between the two scores for Pupil 2 is *twice* the magnitude of the difference between the same scores for Pupil 1. In fact, the former would not be regarded as significant, but the latter certainly would (for further explanation of this see the manual). In practice, scores at the tails of the distribution are much rarer than scores in the middle of the distribution, so differences between them will tend to assume greater significance. The z-score format allows us to determine that significance.

Relationship between centile scores, z-scores and standard scores

Centile scores and z-scores have a consistent relationship to each other (and also to standard scores, which, like IQ, are usually expressed with a mean of 100 and a standard deviation of 15). The table below shows this relationship. Many educational tests (e.g. of reading, spelling and numeracy) use standard scores. If you need to compare LASS 8-11 results with the results of other test, you may need to convert z scores into standard scores before making the comparison. To convert a z score to a standard score, multiply the z score by 15 and if the z score was positive, add the result to 100, or if the z score was negative, subtract the result from 100. Conversely, to convert a standard score to a z score divide the difference between the standard score and 100 by 15. The z score will be positive if the standard score was greater than 100, and negative if less than 100.

centile score	3	5	17	20	25	50	75	83	97
z-score	−2.0	−1.75	−1.0	−0.85	−0.66	0	+0.66	+1.0	+2.0
standard score	70	76	85	87	90	100	110	115	130

Age equivalents

The Summary Table also gives the age equivalent score for each test completed. An age equivalent is defined as the chronological age range of pupils that would be expected to achieve a given raw score (or, in this case, projected score). Age equivalents are relatively crude indices of attainment (in comparison with centile scores and z scores) and so should always be used with caution. However, they can be encountered in some tests of reading and spelling and other measures, and so occasionally teachers may wish to compare such test scores with the results obtained from LASS 8-11.

Age equivalents also provide a suitable way of reporting results of children who are outside the age range for LASS. Although as a general rule, LASS 8-11 should not be used outside the age range for which it is normed (8:0 to 11:11) there are circumstances when it is necessary and appropriate, e.g. in the case of a very bright or advanced six-year-old, or a pupil of twelve or over with moderate or severe learning difficulties. Here, the centile norms may not be particularly helpful because they would be comparing the pupil with (in the first example) eight-year-olds, and (in the second example) eleven-year-olds. In such cases, age equivalents can often provide the teacher with more useful information. In fact, some teachers in special education prefer to work with age equivalents rather than centile scores, because it enables them to conceptualise the ability level of the pupil they are teaching, and so pitch the work at the correct level.

Age equivalents are designed to be used only in special circumstances such as those illustrated above and should not be used routinely in cases where centile norms are applicable, because age equivalents give only a very rough approximation of the pupil's ability. Nor should LASS 8-11 be used routinely above the age of 11 years 11 months because there is an assessment suite designed specifically for, and standardised for use with, this older age group, i.e. **LASS 11-15** (for further information visit the website www.lucid-research.com).

Discrepancy

When we observe the scores obtained by any given pupil, we will almost invariably find some differences. Some scores will be higher than others. But how do we determine whether any observed differences are 'significant'?

By 'significant' we mean 'so much poorer than the level that would be expected on the basis of the person's age and intelligence that the discrepancy is unlikely to be due to normal variation within the population or to chance'. What is important is not so much the *absolute* level of the pupil's performance but rather the *degree of discrepancy* between their observed literacy skills and the level of literacy ability that we would reasonably *expect* such pupils to have. The conventional way in which psychologists make valid comparisons between performance on different tests or measures is by reference to standardised scores (such as centiles or standard deviation units), which have a clear rationale in psychometric test theory and practice.

On the other hand, poor literacy and/or study skills *may* also be the result of inadequate teaching or insufficient learning and/or experience and *do not necessarily* imply that the pupil has dyslexia. Establishing a discrepancy, as well as seeking evidence of neurological anomalies or cognitive impairments, helps the assessor to rule out these environmental factors as primary causes of the pupil's problems. However, the discrepancy model of identification should not be used blindly: it should be part of a more extensive process by which the assessor seeks to build up an understanding of the individual's difficulties based on quantitative and qualitative evidence.

There is an ongoing scientific debate about the role of intelligence in dyslexia (e.g. Ashton, 1996; Frederickson and Reason, 1995; Nicolson, 1996; Siegel, 1989a, 1989b, 1992; Solity, 1996; Stanovich, 1991; Turner, 1997). Some researchers argue that other types of discrepancy have better diagnostic value (e.g. between *oral* language abilities and *written* language abilities, or between *listening* comprehension and *reading* comprehension), although these could be problematic in cases of dyslexic individuals who have developed effective strategies for compensating for reading and writing difficulties. Others suggest that identifying those with chronic difficulty in phonological processing would be the most efficient way of diagnosing dyslexia (Snowling et al, 1997), although by no means all dyslexics seem to have phonological difficulties (Rack, 1997). For further discussion of these issues see the manual.

LASS 8-11 automatically calculates whether or not there is a statistically significant discrepancy between the ***Reasoning*** score and the other scores. First of all, it works out the difference between the z scores, and then determines whether this difference is statistically significant. By convention, statistical significance is shown as the probability [p] of the result occurring by chance, e.g. if the obtained result could occur by chance fewer than 5 times in every 100 occasions, this would represent a 5% level of significance (also sometimes depicted as $p < 0.05$ because the probability statistic p can vary between 0 [never occurs] to 1.0 [always occurs]). In other words, on 95 out of 100 occasions such a result would reflect a *true difference*, as opposed to a *chance variation*.) Correspondingly, the 1% significance level indicates that the obtained result would be expected to occur by chance less than once in every 100 occasions, and the 0.1% significance level indicates that the obtained result would be expected to occur by chance less than once in every 1000 occasions.

However, teachers should not assume that when a given discrepancy is found to be statistically significant this automatically means that the given test score is significantly lower than the ***Reasoning*** score, because the discrepancy might be in the other direction (in other words, the child's reading, or spelling, or memory or whatever, is actually much better than would be expected from their non-verbal reasoning ability). If the given test score is significantly poorer than the ***Reasoning*** score the z score difference will be shown as positive, but if the given test score is significantly better than the ***Reasoning*** score the z score difference will be shown as negative. Teachers should check this by noting whether the number shown in the z score difference column is negative or (−) or positive (no sign shown).

LASS 8-11 does not automatically calculate other discrepancies (e.g. between visual memory and auditory memory) but it is a straightforward matter to do this if required. Simple subtract the z scores of the two tests from each other and look up the result in the following table.

z-score difference	**discrepancy**
less than 0.66	not significant
0.67 to 0.99	significant at 5% level ($p < 0.05$)
1.0 to 1.66	significant at 1% level ($p < 0.01$)
greater than 1.66	Significant at 0.1% level ($p < 0.001$)

In the example given earlier, in which a pupil had a ***Sentence Reading*** score of centile 30 and ***Reasoning*** score of centile 85, the z-scores are –0.67 and +1.12, respectively: a difference of 1.79, which is highly significant at the 0.1% level.[2]

[2] Technically, when calculating discrepancies between scores on psychometric tests, allowance should be made for the statistical phenomenon known as 'regression to the mean'. Regression to the mean is not easy to explain in layman's terms, but it can distort the picture, particularly in cases of children whose scores are near to the extremes on one or other of the tests under comparison. However, to make things as uncomplicated as possible for teachers, the probabilities specified in the table have been set at very conservative levels which in most cases should suffice to compensate for any likely regression effects.

Interpreting scores and profiles

Critical thresholds

How low must a LASS 8-11 individual module result be before the teacher should be concerned about the pupil's performance? Put another way: what is the critical cut-off point or threshold that can be used when deciding whether or not a given pupil is 'at risk'? Unfortunately, this is not a question that can be answered in a straightforward fashion, because much depends on other factors. These include: (a) the particular LASS test undertaken, (b) whether the results of other individual LASS tests confirm or disconfirm the result being examined, (c) the age of the pupil being tested, and (d) the school's or LEA's own SEN criteria or thresholds.

Conventional SEN thresholds are: below 20^{th} centile (i.e. the '1 pupil in 5' category) and below the 5^{th} centile (the '1 in 20' category). At one time, it was maintained that Statements of Special Educational Needs under the *1981 Education Act* would be appropriate for only about 2% of pupils. Experience has shown that this, in general, is far too restrictive and concentrating just on the lowest 2% will result in many pupils with special educational needs being overlooked.

Any individual LASS module result which falls *below the 20^{th} centile* (i.e. near or below *one* standard deviation below the mean) is by definition significantly below average and thus indicates an area of *weakness*. This is a fairly conventional cut-off point in identifying special needs or moderate educational weaknesses. A pupil who falls below this threshold should always be *considered* for intervention of some kind, depending on other factors (see below). Sometimes a weakness is identified which can be remedied by appropriate training. In some cases the problem is more pervasive and requires a differentiated approach to teaching in basic skills. Where there is strong confirmation (e.g. a *number of related tests* at or below the 20^{th} centile) then the assessor can be convinced that concern is appropriate.

Where a pupil is scoring *below the 5^{th} centile* on any particular module (near or below *two* standard deviations below the mean), this generally indicates a *serious difficulty* and should always be treated as diagnostically significant, and usually this will be a strong indication that a pupil requires intervention. Again, where there is strong confirmation (e.g. a *number of related tests* at or below the 5^{th} centile) then the assessor can be even more confident about the diagnosis.

However, it should not be forgotten that LASS is also a *profiling* system, so when making interpretations of results it is important to consider the pupil's *overall profile.* For example, a centile score of 30 for reading or spelling would not normally give particular cause for concern because it does not fall below the 20^{th} centile threshold. But if the pupil in question had a centile score of 85+ on the reasoning module, there would be a significant discrepancy between ability and attainment, which *would* give cause for concern. How this is calculated is described below.

It should also be noted that the ***Single Word Reading*** test is the only test in the LASS 8-11 suite for which scores are not distributed in a normal curve. In fact, there is a significant negative skew, indicating that most pupils will achieve a maximum or near-maximum performance (in statistical terms this is sometimes referred to as a '*ceiling effect*'). The ***Single Word Reading*** test does not have sufficient sensitivity to discriminate amongst pupils within the average range, and so it should be confined to use with pupils who are *significantly behind* in reading development, either to determine their attainment level or evaluate progress.

Understanding profiles

When considering LASS 8-11 results, it is important to bear in mind that it is not one test which is being interpreted, but the performance of a pupil on *a number of related tests*. This is bound to be a more complex matter than single test interpretation. Hence the normative information (about how a pupil is performing relative to other pupils of that age) must be considered together with the ipsative information (about how that pupil is performing in certain areas relative to that same pupil's performance in other areas). The pattern or profile of strengths and weaknesses is crucial. Where appropriate, the teacher can calculate statistical discrepancies between the child's scores on different tests if desired, but in most cases visually examining the profiles will usually give sufficient indication of the areas where a child is underperforming in relation to other scores. This particular skill improves with experience, so teacher's should not be discouraged if at first it seems overly complex.

However, it is *not* legitimate to average a pupil's performance across all tests in order to obtain a single overall measure of ability. This is because the modules in LASS are measuring very different areas of cognitive skill and attainment. It would be like adding the length of a person's legs to their waist measurement in order to obtain a size for a pair of trousers. The trousers would be unlikely to fit very well!

On the other hand, where scores in *conceptually similar areas* are *numerically similar*, it is sometimes useful to average them. For example, if scores on the two memory modules *(**The Haunted Cave*** and ***Mobile**)* were at similar levels, it would be acceptable to refer to the pupil's memory skills *overall*, rather than distinguishing between the two types of memory being assessed in LASS (i.e. visual memory and auditory-verbal memory). On the same basis, if scores on the two phonological modules *(**Funny Words*** and ***Word Chopping**)* were at similar levels, it would be acceptable to refer to the pupil's phonological skills *overall.* Note that this applies only to conceptually similar areas and where scores are numerically similar (within about 10 centile points of each other). It would not be legitimate to average scores across conceptually dissimilar modules (e.g. ***Reasoning*** and ***Funny Words***). When scores are dissimilar, this indicates a differential pattern of strengths and/or weaknesses, which will be important in interpretation. In such cases it will be essential to consider the scores separately rather than averaging them. For example, if ***The Haunted Cave*** and ***Mobile*** produce *different* results, this will usually indicate that one type of memory is stronger or better developed (or perhaps weaker or less well developed) than the other. This information will have implications for both interpretation and teaching.

Teachers should also remember that the computer is not all-seeing, all-knowing — nor is it infallible. For example, the computer cannot be aware of the demeanour and state of the pupil at the time of testing. Most pupils find the LASS tests interesting and show a high level of involvement in the tasks. In such cases the teacher can have confidence in the results produced. Occasionally, however, a few pupils do not show such interest or engagement and in these cases the results must be interpreted with more caution. This is particularly the case where a pupil was unwell at the time of assessment or had some anxieties about the assessment. Teachers should therefore be alert to these possibilities, especially when results run counter to expectations.

Many LASS profiles display a complex pattern of 'highs' and 'lows' that at first sight appears quite puzzling. When tackling such profiles it is particularly important to bear in mind any extraneous factors that might have affected the pupil's performance. Examine the data to see on what days and times different tests were done. Motivation, ill heath (actual or imminent) and impatience are often causes of a pupil under-performing. Or the pupil may simply have 'got the wrong end of the stick' (e.g. assuming that they have to do a test as quickly as possible when in fact it is accuracy which is most important). Very occasionally it may be found in such cases that the child was simply 'messing around' and not taking the test seriously. The fundamental rule of thumb is: if the teacher is not confident about any particular result, then the safest course of action is to repeat the test(s) in question after first checking that the child does understand the task(s), is not unwell, and has the right frame of mind to attempt the activities to the best of their abilities.

Must pupils be labelled?

Labels for different special educational needs (especially the label "dyslexia") have been unpopular for the best part of a generation. However, labels are not always undesirable, and there are signs of a change of opinion amongst educationalists. Although all SEN pupils are individuals, there are broad categories that are useful in teaching. The *1981 Education Act*, which encouraged a non-labelling approach to special educational needs, was then superseded by the *1993 Education Act* and the *Code of Practice for the Identification and Assessment of Special Educational Needs (DfE, 1994).* It is interesting that the latter embodies a fairly broad labelling of special educational needs categories, including the category 'Specific Learning Difficulties (Dyslexia)' [Code of Practice, 3:60]. This development is an acknowledgement of the fact that SEN labels are often necessary to ensure that the pupil receives the right sort of support in learning. Application of LASS 8-11 in relation to the *Code of Practice* is discussed in detail in the manual. More recently, the *1996 Education Act* has consolidated the provisions of previous Acts, in particular the 1993 Act.

On the other hand, there is still a need for differentiation of teaching and learning activities within a single category. This is particularly true of the category 'dyslexia' (or Specific Learning Difficulty), in which some pupils may be affected more in the *auditory/verbal* domain, others in the *visual/perceptual* domain, and a few in *both* domains or who may have *motor difficulties*. Hence, dyslexic pupils may exhibit a variety of difficulties and dyslexia has been described as a variable syndrome (Singleton, 1987). Nevertheless, dyslexia is a condition that can usually be helped tremendously by the right type of teaching, even though dyslexic pupils cannot all be taught in exactly the same way (Thomson, 1993; Augur, 1990; Thomson and Watkins, 1990; Miles, 1992; Pollock and Waller, 1994).

Many teachers are justifiably worried that labelling a pupil — especially at an early age — is dangerous, and can become a 'self-fulfilling prophecy'. Fortunately, the LASS approach does *not* demand that young pupils be labelled — instead it promotes the awareness of pupils' individual learning abilities and encourages taking these into account when teaching. Since the LASS graphical profile indicates a pupil's cognitive *strengths* as well as *limitations*, it gives the teacher important insights into their learning styles. In turn, this provides essential pointers for curriculum development, for differentiation within the classroom, and for more appropriate teaching techniques. Hence it is not necessary to use labels such as 'dyslexic' when describing a pupil assessed with LASS, even though parents may press for such labels.

The term 'dyslexia' is often reserved for those pupils who show a significant discrepancy between ability and attainment that is known to be caused by particular cognitive limitations. Dyslexics also tend to show particular patterns of strengths and weaknesses. By identifying cognitive strengths and weaknesses it is easier for the teacher to differentiate and structure the pupil's learning experience in order to maximise success and avoid failure. By appropriate early screening (e.g. with ***CoPS Cognitive Profiling System***, or **LASS 8-11**) the hope is that pupils who are likely to fail and who might subsequently be labelled 'dyslexic', never reach that stage because their problems are identified and tackled sufficiently early. (This is not to suggest that dyslexia can be 'cured', only that early identification facilitates a much more effective educational response to the condition.)

It is often satisfactory (especially where younger children are concerned) to explain to the parents that the screening or assessment using LASS reveals the cognitive (or learning) strengths and weaknesses of *all* pupils. If LASS has shown some weaknesses in certain areas for a given pupil the parents may be informed that the school will be addressing those weaknesses with appropriate teaching. Where LASS is being used as an assessment device for diagnosis of older pupils who are already failing in literacy and parents are aware of this (as they should be if the child is already on the SEN register), explanations necessarily have to be more complex. Labels such as 'dyslexic' may become more appropriate and/or unavoidable. Nevertheless, the emphasis should still be on matching teaching to the child's pattern of strengths and weaknesses. The British Dyslexia Association provides advice for teachers and parents on these matters.

Interpreting results of pupils who are outside the LASS 8-11 norms range

LASS 8-11 is normed for use with pupils in the age range 8 years 0 months to 11 years 11 months. Over the age of 11:11, LASS 8-11 raw scores will not conform to a normal distribution because many pupils will achieve a maximum or near-maximum performance (in statistical terms this is sometimes referred to as a '*ceiling effect*'). Similarly, below 8:0, most pupils will obtain very low scores on the LASS 8-11 tests, which will create a bunching of scores at the lower end of the distribution (sometimes called a '*floor effect*'). When ceiling and floor effects occur in any test, it is not a good discriminator between pupils with differing abilities.

The norms for LASS 8-11 only extend to 11:11, so it can only be used *psychometrically* (i.e. to compare a given pupil's performance with that of other pupils of the same age) up to that age. However, over this age range it can have a certain limited value if used *clinically* (i.e. to identify pupils with particular difficulties), or *ipsatively* (i.e. to compare a given pupil's performance on one test with the same pupil's performance on another). When employed in this way with older individuals, it should always be used with *extreme caution*, and then only by experienced professionals who fully appreciate the limits within which they are working. Many older individuals with significant cognitive problems (e.g. dyslexia) are likely to experience difficulties on some LASS tests. Nevertheless, this is not *necessarily* the case. When used with older individuals, absence of any indications of difficulty on LASS tests must *never* be taken as evidence that there *are no* underlying difficulties because the tests may just not be sensitive enough. In any case, older persons typically develop strategies by which they can compensate for any cognitive limitations, and these can have a masking effect, preventing any limitations from showing up in assessments.

The preferred solution to assessment of pupils older that 11 years 11 months is to use **LASS 11-15** (11:0 – 15:11). Pupils younger that 8:0 should be assessed with **CoPS Cognitive Profiling System**. For information on these assessment products, contact Lucid or visit the website (www.lucid-research.com).

Under exceptional circumstances, age equivalent scores can be used when assessing pupils outside the norm range. An age equivalent is defined as the chronological age range of children that would be expected to achieve a given raw score. Age equivalents are designed to be used only in exceptional circumstances, e.g. for pupils in special education where centile norms are not always helpful. Age equivalents should not be used routinely in cases where centile norms are applicable, because age equivalents give only a very rough approximation of the child's ability.

Age equivalent for LASS 8-11 scores are shown in the Summary Table for each child. Note that it is not possible to provide age equivalents for the ***Single Word Reading*** test. This is because the scores for this test are not distributed in a normal curve — in fact, there is a significant negative skew — indicating strong ceiling effects. This is explained in the manual.

Example A

Bruce, chronological age 13 years 3 months, has moderate learning difficulties. His measured IQ on WISC-III was 64, which indicates that his mental age is about eight and a half. He has Projected Scores of 84 on ***Sentence Reading*** and 29 on ***The Haunted Cave***. His centile scores for these tests shown on the LASS Graphical Profile were 50 and 49, respectively, suggesting that he is average, but of course the norms will automatically compare him with 11 year-olds. However, the Summary Table shows that on ***Sentence Reading*** Bruce's score places him within the 8:6 – 8:11 age equivalent range, i.e. about three and half years behind chronological age levels, but roughly what would be expected from his IQ. On ***The Haunted Cave*** Bruce is at the 11:0 – 11:5 age level, which is only about two years behind chronological age levels and, in fact, rather better than would be predicted from his IQ. In other words, visual memory is a *relative strength* for Bruce, and hence his teachers can make good use of that in learning and teaching.

Example B

Kayleigh is a very bright girl aged 6 years 6 months. Her reading skills are believed to be at least three years ahead of her chronological age level. However, her teacher wants to know whether the cognitive skills that underpin reading are as well developed. The teacher administers LASS, finding that Kayleigh obtains projected scores of 25 on ***The Haunted Cave***, 5 on ***Mobile***, and 16 on ***Funny Words***. The LASS Graphical Profile gives centile scores of 64, 16 and 37, respectively for these tests, which is not particularly helpful as these compare Kayleigh results with that of eight-year-olds. The age equivalent scores given in the Summary Table show that Kayleigh is at the 9:6 – 9:11 age level for ***The Haunted Cave***, and at the 8:0 – 8:5 age level for both ***Mobile*** and ***Funny Words***. From this is can be deduced that Kayleigh is probably relying heavily on visual memory when reading and that her phonic skills are not quite as good as might have been expected. A relevant factor would appear to be her auditory-verbal memory, which although above average, is probably not in step with her overall intelligence.

Interpreting results from individual tests

Reasoning

The purpose of the ***Reasoning*** module is to give the assessor a reasonable estimate of the child's general intellectual ability or intelligence. This is a matrix test, in which both visual and verbal reasoning strategies may be employed. There is good evidence that such matrix reasoning tests correlate well with more extensive measures of intelligence and therefore provide a good overall indicator of general intellectual ability. Nevertheless, assessors should be aware that a *small proportion* of pupils may experience difficulties with this task, even though in other respects their intelligence levels are at least average. Hence in cases of low scoring where the assessor is puzzled by the result because it does not seem to accord with expectations, it would be wise to check the pupil's intelligence using an alternative measure, such as the *NFER-NELSON Verbal and Non-Verbal Reasoning Test Series*, or the *British Picture Vocabulary Scale (BPVS)*[3]*.*

The ***Reasoning*** module in LASS 8-11 is not intended to be a speeded test (i.e. performed against the clock), but in the interests of avoiding excessively lengthy assessment sessions, a (fairly generous) time limit of 60 seconds has been allowed for each item. For most pupils, this should allow sufficient time for a reasonable attempt at each item. To allow greater time would not increase validity or reliability of the test, so if pupils run out of time then this must be accepted as part of the exigencies of the task.

Sentence Reading

Sentence Reading will often be the first test to be administered. Like the reasoning module, it is also an adaptive test, which makes assessment swift and efficient. ***Sentence Reading*** involves both *reading accuracy* (i.e. word recognition using phonological decoding skills and/or whole-word visual strategies) and *reading comprehension* (because in order to decide which of the words offered is the correct word to fit into the sentence, the pupil has to have some understanding of the meaning of the sentence). Hence it gives a good general estimate of the overall reading skills of pupils in this age range.

In cases where the pupil scores at least within the average range on the ***Sentence Reading*** module, and there is no significant discrepancy between this result and the score on the ***Reasoning*** module, there is usually no need to administer the other two reading-related modules (***Single Word Reading*** and ***Funny Words***). This is because the pupil's performance in reading will not give undue cause for concern. However, if the score of this module falls below centile 20, or there is a significant discrepancy between this result and the score on the ***Reasoning*** module, then there will be cause for concern. In this event it is recommended that both the ***Single Word Reading*** and ***Funny Words*** tests also be administered.

Single Word Reading

This is a test of word recognition out-of-context: i.e. reading accuracy. ***Single Word Reading*** is the only test in the LASS suite for which scores are not distributed in a normal curve. In fact, there is a significant negative skew, indicating that most pupils will achieve a maximum or near-maximum performance (in statistical terms this is sometimes referred to as a *'ceiling effect'*). The ***Single Word Reading*** test does not have sufficient sensitivity to discriminate amongst pupils within the average range, and so its use should be confined to

[3] These tests are available from NFER-Nelson.

pupils who are *significantly behind* in reading development, either to determine their attainment level or evaluate progress.

Hence there is generally little point in administering ***Single Word Reading*** unless the teacher suspects that the pupil is a poor reader, because:

- the pupil has scored below the threshold of concern (less than centile 20) on the sentence reading module; or
- a significant discrepancy between the score for the sentence reading module and the score on the reasoning module has already been detected; or
- there is other evidence to suggest deficient reading skills.

In such cases, the purpose of administering this module is to ascertain whether there is a serious deficiency in word recognition as well as reading comprehension (the latter being judged on the basis of the pupil's performance on the ***Sentence Reading*** test or some other reading comprehension test). Where the ***Single Word Reading*** test is administered, teachers should be aware that results may not correspond to those obtained from an oral single-word recognition test in which the child has to pronounce the words in the test. This is obviously a rather different (and considerably harder) task than that of identifying the target word on hearing the word spoken by the computer, as in LASS. Where the teacher is in doubt it would be prudent to check the child's oral word recognition skills using a suitable test.

Funny Words

This is a test of nonword reading. Nonwords (sometimes called 'pseudowords') are letter strings that are not recognised words in a given language (in this case English), but could be – i.e. they conform to orthographic rules of the language. For example, 'gade' or 'tiphalune' are not English words but are nevertheless pronounceable as though they were words, using phonological decoding skills (and, possibly, analogy processes, e.g. 'gade' might be rhymed with 'fade' or 'glade'). If a pupil pronounced 'gade' as 'gad´ee' (instead of applying the silent 'e' rule which changed the short 'a' to a long 'a'), or 'tiphalune' as 'tip´hall´unee' (instead of 'tif´aloon' or 'ti´farloon'), we would have good evidence that the pupil does not possess the appropriate phonological decoding rules (often referred to by teachers simply as 'phonics'). In some cases there may be other phonological problems, such as difficulties in sequencing phonemes or syllables (e.g. the pupil may pronounce 'tiphalune' as 'till´a´foon'), additional to – or instead of – failure to apply rules of phonics.

Pupils with dyslexia typically experience difficulties in reading nonwords (Snowling and Hulme, 1994). Indeed, there is evidence from a wide range of different tasks (not just nonwords) that individuals with dyslexia of all ages generally find phonological activities difficult (Bruck, 1992, Snowling et al, 1997, Snowling, 2000) and there is a school of scientific thought that regards dyslexia as essentially a phonological processing difficulty (Rack, 1994; Snowling, 1995, 2000). Hence a low score on the LASS 8-11 ***Funny Words*** module is usually a good indication of dyslexia. However, teachers should be aware that there are other possible explanations for a low score on ***Funny Words***, including:

- the pupil has never been taught phonics properly
- the pupil has insufficient experience of English
- the pupil has hearing problems

In order to resolve these possibilities, the teacher will need to consider other relevant evidence (such as medical history or information about the pupil's primary or elementary schooling) but must also take into account the pupil's performance on the other LASS modules. For example, if the pupil also performs poorly on ***Word Chopping***, then this would support conclusions of a phonological processing difficulty. However, although it is true that *most* pupils with dyslexia have phonological processing difficulties, there are some cases of dyslexia that do not display such difficulties (Beaton, McDougall and Singleton, 1997b; Rack, 1997; Turner, 1997). Hence teachers should beware of assuming that because a pupil does not have a low score on ***Funny Words*** he or she cannot therefore have dyslexia.

By inspecting the data pages for ***Funny Words***, the assessor can examine the pupil's results in detail. This will help to determine whether the problem is mainly one of hearing – in which case errors will usually be scattered throughout the test – rather than poor phonics skills, in which case errors will tend to increase as the test gets more difficult.

Lack of experience with English can limit awareness of pronunciation rules. For example, in one of the more difficult items in ***Funny Words***: 'troughilicancy' (pronounced 'troff´ill´ick´an´see'), in order to select the correct answer a pupil needs to know that '–ough' is pronounced '–off' and that 'c' followed by a vowel is usually pronounced 'k' but when followed by a 'y' is pronounced 's'). Inspection of the data pages for ***Funny Words*** will enable the assessor to determine the nature of the pupil's difficulties in these respects. Further guidelines on interpreting results obtained by pupils for whom English is an additional language may be found in the manual.

Word Chopping

Word Chopping is test of general phonological processing abilities requiring deletion of segments of words. For example, 'butterfly' without the syllable 'ter' would be pronounced 'buh´fly' (strictly: not 'but´fly', unless one was using knowledge that the word was spelt with a double 't', rather than relying on the sounds of the syllables).

As children learn to talk they develop increasingly sophisticated cognitive representations for phonological aspects of speech. They become aware that words can be *segmented* into syllables (e.g. that 'wigwam' is composed of 'wig' and 'wam'), and that different words can contain similar elements (i.e. similar *onsets* like **w**-ig and **w**-am, or similar *rimes* like w-**ig** and p-**ig**). The importance of this phonological awareness for early literacy development has been very well demonstrated in research carried out all over the world in the past twenty years (for reviews and discussion of issues, see Snowling, 1995; Goswami, 1994, 1999, 2001; Goswami and Bryant, 1990; Rack, 1994; Savage, 2001). Phonological awareness in very young children is often assessed by means of an 'oddity task' in which the child has to pick out the one which is different from of list of similar sounding words, e.g. *'mop, hop, tap, lop'; 'ham, tap, had, hat'* (Bradley and Bryant, 1983; Bradley, 1980). However, phonological deletion tasks, such as ***Word Chopping***, have been found to be more sensitive measures for use with older children (Snowling, 2000).

Dyslexic children are known generally to have poor phonological skills (Rack, Snowling and Olson, 1992; Holligan and Johnston, 1988). In the *phonological deficit model of dyslexia* (Hulme and Snowling, 1991; Snowling, 1995, 2000) it has been hypothesised that the status of children's underlying phonological representations determines the ease with which they learn to read, and that the poorly developed phonological representations of dyslexic children are the fundamental cause of their literacy difficulties. In the CoPS research the *Rhymes* test was found to be a highly significant predictor of later literacy skill (Singleton, Thomas and Horne, 2000).

There is good evidence that individuals with dyslexia of all ages have persistent difficulties with phonological deletion tasks (Bruck, 1990, 1992; Gottardo, Siegel and Stanovich, 1997; Snowling, 2000; Vellutino et al, 2004). Low performance on ***Word Chopping*** is therefore a good indication of dyslexia. However, like ***Funny Words***, teachers should be aware that pupils with hearing problems may also have low scores on ***Word Chopping***. By inspecting the data pages for the module, the assessor can examine the pupil's results in detail. This will help to determine whether the problem is mainly one of hearing – in which case errors will usually be scattered throughout the test – rather than phonological processing, in which case errors will tend to increase as the test gets more difficult.

Spelling

Some teachers take the view that spelling is the least important aspect of literacy and therefore may not bother to assess it. However, many pupils with specific learning difficulty or dyslexia – especially if they have had a lot of support or special tuition during primary education – may have improved reading skills to the extent that a significant discrepancy between ***Reasoning*** and reading ability is no longer apparent. In most cases, however, spelling is much more difficult to remediate, and so it is important to assess this aspect of literacy because it can shed light on underlying problems that teachers might remain unaware of. Poor spelling (especially in pupils who are bright and have otherwise satisfactory reading skills) often signals deeper cognitive difficulties (e.g. in memory) that can create problems in many aspects of educational performance, ranging from modern languages to mathematics.

Pupils with spelling problems tend to experience difficulties with writing generally (Moseley, 1997). This is not only because they have anxieties about not being able to spell words, but also because they are so focused on the *mechanics* of the writing process (spelling, grammar, punctuation) that they have little cognitive capacity left over to monitor the meaning of the text they are producing. They easily lose track of what they want to say, miss words out and leave sentences incomplete. To resolve these difficulties, pupils may resort to a 'dumbing down' strategy: i.e. writing in a very immature fashion, using easy-to-spell words and simple sentence structures. The resultant written work may not actually contain very many errors but is far below the standard that the pupils should be capable of, given their levels of understanding. Ideally, spelling – like the other mechanical processes of writing – should be automatised, i.e. be so well practised that they operate largely at a subconscious level, which frees up conscious processes to concentrate on the meaning of what is being written.

It should be noted that poor spelling does not inevitably indicate dyslexia. Indeed, when pupils with poor spelling have no underlying cognitive difficulties that would be indicative of dyslexia, it is usually the case that they have never been taught to spell properly or have had insufficient practice in using their spelling skills so that these skills become automatised.

The Haunted Cave

The Haunted Cave is a test of visual memory, involving spatial and temporal sequences. However, since the stimulus items for ***The Haunted Cave*** can be encoded by use of verbal labels, the part played by verbal memory skills in this task is potentially as great as that played by visual memory. Although auditory-verbal memory is usually regarded as being of greatest significance where literacy skills are concerned (see next section), there is good evidence that visual memory tasks can also give good indications of dyslexia and literacy difficulties (Awaida and Beech, 1995; Beech, 1997; Singleton, Thomas and Leedale, 1996; Singleton, Thomas and Horne, 2000). Hence in cases of literacy difficulties it is important for the teacher to know whether the pupil's visual memory skills are weak or strong, as these will not only affect the diagnosis but also have implications for subsequent teaching recommendations.

Although working memory is typically conceptualised as being a phonological system subserving speech, a visual equivalent known as the 'visuo-spatial scratch pad' has been hypothesised (Baddeley, 1996). This is believed to enable us to keep small amounts of visual information in short-term memory. Such a system is important in developing visual strategies in reading, especially those used by beginning readers ('look and say'). Models of reading acquisition suggest that visual memory is particularly important in the early stages of learning to read (e.g. Ehri, 1995; Frith, 1985). Conclusions reported by Passenger, Stuart and Terrell (2000) from their study of 80 preliterate children during their first year of formal schooling lend some support for this view. Stuart, Masterson and Dixon (2000) also found that visual memory influences the acquisition of sight vocabulary in children aged 5 who displayed poor graphophonic skills (i.e. those who had not yet acquired the ability to segment words on the basis of their sounds and who displayed little or no knowledge of sound-to-letter mappings). For children with good graphophonic skills, however, no association between visual memory and word learning was found. Visual memory is also essential in rapid retrieval of visual whole-word representations from the mental lexicon by older and more fluent readers when reading text (particularly of irregular words for which a phonic strategy would not be appropriate). Visual memory also comes into play when retrieving visual sequences of letters in the correct order for spelling (again, particularly where irregular words are concerned). Hence visual memory is a key component of literacy development.

There is also evidence that poor readers have a bias towards visual encoding of words. Johnston and Anderson (1998) reported that poor readers showed a preference for using pictorial rather than verbal information, which they suggest may arise from previous difficulties in learning to attach verbal labels to visual stimuli. Ellis, McDougall and Monk (1996) reported that dyslexics aged 10 years were significantly faster on some visual processing tasks (e.g. picture categorisation) than other groups, including reading age (RA) controls. On word recognition tasks in which the words are paired with either visually similar cues or phonologically similar cues, poor readers are known to perform *better* than RA controls on the visually similar cue items but not on the phonologically similar cue items (Holligan and Johnston, 1988; Rack, 1987). In other words, they display a less pronounced phonological similarity effect and a more pronounced visual similarity effect (Katz, 1986; Mann and Liberman, 1984).

Palmer (2000) used the *Corsi Blocks* test to measure visuospatial span in three groups of 14 year-old pupils: dyslexics, RA controls, and chronological age (CA) controls with normal reading ability. The *Corsi Blocks* test comprises a set of nine blocks fixed to a base in a predetermined pattern. The test administrator touches the blocks in a set sequence and the testee is required to recall that sequence by touching the same blocks in the same order. This has a direct parallel with ***The Haunted Cave*** in LASS 8-11. Palmer found that the dyslexic group significantly outperformed the RA controls on this test. The results also suggested that while all participants showed evidence of using phonological coding to remember pictures, only those in the dyslexic group used visual coding.

Another study by Palmer (2001) provides further evidence that it is useful for teachers to know about children's visual memory skills. In this experiment, it was found that children who maintained a visual representation of words alongside a phonological representation after age 7, were significantly worse readers than those for whom the ability to switch strategies by inhibiting the visual representation had fully developed. Children with good visual memory but poor auditory-verbal memory would not only be expected to find acquisition of an effective phonological decoding strategy in reading rather difficult, but also be inclined to rely for a longer period on visual strategies. This approach is liable to run into trouble as the child's education progresses and the number of new words with which the child is confronted steadily increases.

Some teachers and psychologists assume that problems with short-term memory are entirely verbal rather than visual. However, research suggests otherwise. Awaida and Beech (1995) found that ability to remember letter-like forms at four years of age correlated with reading skills one year later. There is a substantial literature on subtypes of dyslexia, in which visual deficits predominate (Thomson, 1993; Pumfrey and Reason, 1991). Some tests for dyslexia incorporate visual memory tests, e.g. *The Aston Index* (Newton and Thomson, 1982) and the *Coding* sub-test of WISC-III^{UK}, which is one of the key elements of the A–C–I–D profile that is often used as an indicator of dyslexic difficulties (Thomson, 1993). In the CoPS project, WISC Coding given at age 8:0 correlated 0.36 ($p<0.05$) with the *Rabbits* test (a forerunner of ***The Haunted Cave***) administered at age 5 (Singleton, Thomas and Horne, 2000). Fein, Davenport, Yingling and Galin (1988) found that visual memory is a factor which may be separated from verbal memory in some cases of dyslexia. Finally, there are a variety of other research themes focusing on more physiological aspects of 'visual dyslexia', including work on visual discomfort (e.g. Wilkins, 1991; Wilkins et al, 2001); atypical eye movements in reading (e.g. Pavlidis, 1985); ocular dominance (e.g. Stein, 1991, 1994; Stein, Talcott and Witton, 2001); and defects in the transient visual system (e.g. Lovegrove, 1991, 1993, 1994). However, perhaps with the exception of visual discomfort (sometimes referred to as the 'Irlen syndrome', after Irlen, 1991) the evidence on some of these physiological issues at the present time seems to be equivocal and more research is required before they can be of practical value in diagnosis and education (Stanley, 1994).

The Haunted Cave also requires careful concentration and good visual attentiveness, since the stimulus items are only displayed for very brief periods of time. Therefore it is possible for a pupil to perform poorly on ***The Haunted Cave*** not because of inherent memory difficulties, but because of attention deficit disorder. Where this appears to be a serious possibility, teachers should refer to other information about a pupil in order to resolve the issue, or refer the child to an educational psychologist for further investigation. Teachers should be aware that it is possible for pupils to have attention deficit disorder (ADD) without hyperactivity (the latter usually being referred to as AD/HD). ADD (sometimes styled 'AD/HD without hyperactivity') is characterised by persistently poor concentration and attention, daydreaming and passivity. Unlike AD/HD, it is more common in girls and often goes undiagnosed, but can be a significant cause of learning difficulties (Cooper and Ideus, 1995). Pupils with AD/HD who have hyperactive patterns of behaviour may also experience difficulties with ***The Haunted Cave*** because of high impulsivity, which can disrupt the processes of memorisation and recall.

Pupils with very good scores on ***The Haunted Cave*** (or who show marked discrepancies between scores on this test and ***Mobile***) may develop over-reliance on visual strategies in reading, with a consequent neglect of phonic strategies. Although such children may develop quite a large sight vocabulary and superficially may appear to be progressing well in their reading development, this state of affairs is not satisfactory because without adequate phonic skills (that have become fluent through regular use and practice) they are highly likely to struggle in reading later on in education. The teacher can always check the child's phonic skills by using the LASS 8-11 ***Funny Words*** test, but this will not reveal whether children are actively *applying* their phonic skills in text reading. Some children (particularly if they are bright) develop the maladaptive strategy of skipping words in text that they do not recognise immediately, and using their common sense to construct the meaning of the text in the absence of the skipped words. Although they may get away with this in the primary classroom, they are likely to find that such a strategy lets them down badly when they get to secondary school, where they will be introduced to many new, often difficult, words. Teachers should therefore try to prevent this by (a) ensuring that all children have a good working knowledge of phonics, and (b) can apply those phonic skills fluently when reading text. The latter should be apparent when listening to a child read an unfamiliar piece of text aloud. A miscue analysis approach could be adopted, which will help the teacher to identify what type of reading errors the child is making. Fluency in text processing can only be achieved by proper practice in reading: teachers should beware that although children may claim to read regularly (e.g. at bedtime) this may involve reading rather unchallenging material. When reading some children's stories, for example, it is often much easier for the child to skip words that they cannot recognise and still retain a fairly high level of comprehension. By contrast, reading of non-fiction material and 'classic' children's fiction (which often contains a more sophisticated vocabulary) is more likely to encourage children to decode unfamiliar words. However, the text should not be *too* difficult for the child to tackle otherwise the activity will become excessively frustrating and counterproductive. Ideally there should be no more than about 5% of words that are unknown to the child. More than that amount will mean that the child is too frequently interrupting text reading processes in order to decode unfamiliar words, with the result that it will be difficult for them to hold the meaning of the passage in memory.

Mobile Phone

Mobile Phone (usually referred to just as '***Mobile***') is a test of auditory-verbal sequential short-term memory, based on recall of digits. It is a well established fact that individuals with dyslexia or specific learning difficulty typically experience problems with recall of digits (Beech, 1997; Thomson, 1993; Turner, 1997), and digit span is a feature of the vast majority of assessment batteries used for diagnosis of dyslexia (Reason, 1998). Although digit span is normally a spoken test, there is good evidence that the form of the test used in LASS correlates highly with traditional forms, such as those used in the Wechsler Intelligence Tests and the British Ability Scales, and is therefore a valid measure of auditory-verbal memory.

Auditory-verbal short-term memory is critical for literacy development, especially for the acquisition of phonic skills, i.e. mapping of letters (graphemes) on to sounds (phonemes), and for the storage of phonological codes in short-term memory during word recognition and processing of text. There is also a well-established connection between reading and memory (for reviews, see Baddeley, 1986; Beech, 1997; Brady, 1986; Jorm, 1983; Wagner and Torgesen, 1987). The predominant view in the research literature is that phonological processes underpin the development of a phonological recoding strategy in reading, and that working memory plays a significant role in this strategy, enabling constituent sounds and/or phonological codes to be held in the short-term store until these can be recognised as a word and its meaning accessed in long-term memory (e.g. Gathercole and Baddeley, 1993a; Wagner et al, 1993).

Short-term auditory/verbal memory is sometimes called *'working memory'* because it is the system which we use when we have to hold information for a brief period of time while we process it. Working memory is a limited-capacity system, and unless rehearsed or transferred to longer-term storage, information in working memory is only retained for a few seconds (Baddeley, 1986). For example, in order to understand what a person is saying to us we have to hold their words in working memory until they get to the end of a sentence (or equivalent break), then we can process those words for their meaning. We cannot process each individual word for meaning as we hear it because by themselves words do not convey sufficient meaning. Furthermore, words heard later in an utterance can substantially alter the meaning of words heard earlier (e.g. "The man opened the magazine — then he carefully extracted the remaining bullets it contained"). Other examples of working memory include trying to hold a telephone number in mind while we dial it, and carrying out mental arithmetic.

The relevance of auditory/verbal working memory to literacy skills should be obvious — in the same way that it is necessary to hold spoken words in memory in conversation, the child must hold *letters and syllables* in memory when decoding words. This is very important in the development of phonic skills. The majority of dyslexic children have problems in this area of cognitive processing (Thomson, 1989). Awaida and Beech (1995) found that phonological memory at age 5 predicted nonword reading (i.e. phonics skills) at 6 years. When reading continuous text for meaning the child must also hold *words* in memory until the end of the phrase or sentence. Poor working memory will thus affect reading comprehension. Of course, *visual* memory skills will be involved in much of this cognitive activity, especially for beginning readers who have not progressed to phonics, and also for more competent readers whose capacity for rapid visual recognition of words steadily increases with age. Nevertheless, auditory/verbal working memory remains a significant factor in reading development and in writing as well. Children with weaknesses in auditory/verbal working memory also tend have difficulty in *monitoring* their written output, and are inclined to miss letters, syllables and/or words out when they are writing. (For reviews of research on the connections between verbal memory and reading see Baddeley, 1986; Brady, 1986; Jorm; 1983; Wagner and Torgeson, 1987.)

More recently, further research has suggested a very close connection between auditory memory span and articulation (speech) rate (Avons and Hanna, 1995; McDougall and Hulme, 1994). It could well be that articulation rate is an index of the efficiency with which phonological representations of words can be located in memory and activated (i.e. spoken). In turn, this could be closely related to how quickly cognitive representations of words being read can be located in the orthographic and semantic lexicons and activated (i.e. recognised and understood). The three lexicons (phonological, orthographic and semantic) are all believed to be closely related (Rayner and Polatsek, 1989).

Like the other auditory tasks in LASS, ***Mobile*** requires adequate hearing ability. Where a teacher suspects that a low score on ***Mobile*** could be due to poor hearing, inspection of the data pages should help to resolve the question. If the problem is mainly one of hearing, errors will usually be found to be scattered throughout the test results. If it is due to poor memory, errors will tend to increase as the test progresses and the memorisation load steadily increases.