Identifying Dyslexic Students: The need for computer-based dyslexia screening in higher education
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ABSTRACT:
Dyslexic university students can only be provided with support if their disability is identified. However, diagnosis is expensive and time consuming. Quality screening tools, which are generally short and easy to administer, provide robust indications of whether or not a person is likely to be dyslexic. Administering free screening to all students would allow those at risk to be identified and diagnostic testing to be provided in a cost-effective, targeted manner. However, HE students differ significantly from the general adult population: dyslexic students are highly intelligent and most have developed advanced compensatory strategies that effectively mask their disability on screening tests developed for use in the general adult population. Moreover, for a screening test to be made freely available to all students, it must be delivered in a computer-based format. Existing instruments have insufficient discriminatory power for the HE population, or are unsuitable for delivery to all students, which is only possible (due to resource implications) with a computer-based test. There is a pressing need for a test specifically targeted at students, which can be used for widespread, cost-effective dyslexia screening

Current Context

UK Higher Education Statistics Agency figures reveal that around 5.5% of university students are disabled; dyslexia represents around 40% of this subset (i.e. 2.2% of all students are dyslexic). Compared with a 4% estimated incidence in the general population (DSM-IV)\(^1\), dyslexics\(^2\) appear to be under-represented in UK universities\(^3\). From September 2002, the Disability Discrimination Act requires that UK educational institutions make reasonable adjustments to allow students with disabilities to study without disadvantage compared to non-disabled students. These provisions are vital in allowing current dyslexic students to succeed, while encouraging other dyslexics to consider higher education (HE). In order for universities to

\(^1\) However, the British Dyslexia Association (2006) states that approximately 10% of the UK population is dyslexic, of which 4% are severely affected (The Dyslexia Handbook 2006). As discussed in the second section of this paper, different definitions of dyslexia give rise to different estimates of incidence in the general population and also in specific sub-groups, such as students.

\(^2\) A recent discussion by a forum for professionals in dyslexia research and support, indicated that the use of the term ‘dyslexic’ to describe an individual with dyslexia was often preferred by dyslexics themselves. Therefore, the terms ‘dyslexics’ and ‘dyslexic students’ will be used interchangeably.

\(^3\) Although the article refers primarily to statistics and procedures in the UK, the need for a computer-based screening tool targeted at university students exists in many other countries.
provide reasonable adjustments, students must be identified as having a
disability. Of the UK students who are identified as dyslexic when they leave
university, only an estimated 57% are identified on entry to university
(Singleton et al., 1999); therefore, universities play a vital role in identifying
dyslexia. However, there may be students with dyslexia who are not
identified before or at university.

Formal dyslexia diagnosis by an educational psychologist costs around £300
(British Dyslexia Association, 2004) and is usually funded by the student;
only the result of such an assessment is considered a definitive diagnosis of
dyslexia or definitive decision that the individual is not dyslexic. Formal
assessment takes around three hours, including a battery of cognitive tests,
and an ‘interview’ to discuss the individual’s educational and personal history
to identify any everyday dyslexic difficulties, and to reveal any complicating
factors (e.g. other disability or lack of educational opportunity). As full
assessment is time-consuming, expensive and requires administration by
highly-trained professionals, it is not possible to make it available to all
students.

The purpose of dyslexia screening is to provide reliable results which indicate
the probability that an individual is dyslexic; screening is employed to
identify which students are most likely to benefit from a full assessment,
allowing for effective allocation of resources. Screening can involve an
interview, self-completion questionnaire, professionally administered tests, or
any combination of these elements. As screening does not constitute a
diagnosis, it requires only limited information and can be administered
without expert knowledge; the shorter a screening test is, provided it gives
reliable results, the more resource-effective it is. Singleton et al. (1999)
recorded that 70% of UK universities offer dyslexia screening; it is likely that
all universities will offer screening in the near future.

**Operationalising Definitions and Theories of Dyslexia**

One of the major challenges in developing tests to screen for dyslexia is the
lack of a single, accepted definition of dyslexia (Beaton & Singleton, 1997).
Different screening tests are based on different models, derived from
different definitions of what constitutes dyslexia, and thus produce different
diagnostic results, hence the variation in estimates of the incidence of
dyslexia from 0.3 to 30% (Cornwall et al., 1984; see footnote 1).

The World Federation of Neurology (1968) defines dyslexia as: ‘a disorder
manifested by a difficulty in learning to read despite conventional
instruction, adequate intelligence and socio-cultural opportunity. It is
dependent on fundamental cognitive difficulties which are frequently of a
constitutional character’ (World Federation of Neurology [WFoN], 1968,
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pp. 21-22). Genetic research (Gallagher et al., 2000; Petryshen et al., 2001) and neuro-imaging studies, demonstrating significant differences in the structure and usage of dyslexic’s brains (Backes et al., 2002; Shaywitz et al., 2002; Simos, 2002), have led to widespread agreement over the second part of this definition. While most researchers concur that difficulties with written language (i.e. reading, writing and spelling) are the primary ‘symptoms’ of dyslexia, many different ‘fundamental cognitive difficulties’ have been suggested as underlying these problems.

Although dyslexics have difficulties learning to read, many eventually acquire adequate skills, while others are able to study at university, which presupposes advanced written language skills. This begs the question: if university students with dyslexia can compensate for written language difficulties, what other factors are useful for identifying their disability, or has it been ‘cured’? If only 57% of dyslexic students were diagnosed when starting university (Singleton et al., 1999), then (despite strong written language skills) dyslexic students must still evidence difficulties in order to be identified and diagnosed at this point.

Phonological deficit theories are supported by a large body of research (Bradley & Bryant, 1978; Goswami, 2000; Snowling, 1987, 1997) and have been successful in explaining cross-linguistic variations in the incidence and characteristics of dyslexia (Goswami, 2002; Seymour et al., 2003). Most current remedial programmes focus heavily on developing phonological skills, and have demonstrated a high level of success with this approach: as such, dyslexia theories focusing on phonological deficits are currently the most widely accepted as explanatory models.

A growing body of research has detailed dyslexics’ visual deficits (Eden et al., 1996; Facoetti & Turatto, 2000), although, despite a focus on the magnocellular system, the field is divided as to the precise nature of these deficits. Automatisation deficit theories, now linked to the cerebellum (Finch et al., 2002; Moore et al., 2003), suggest a difficulty in automatising basic skills (which often involve sequencing processes) as the underlying causal factor in dyslexia (Denckla & Rudel, 1976; Nicolson & Fawcett, 1990; van der Leif & van Daal, 1999). Another possible key factor is the short term memory (STM) deficit exhibited by most dyslexics; as this deficit is so pervasive, most dyslexia tests include at least one STM measure (McLoughlin, 1993; Miles, 1997).

These deficits are assumed to underlie the acquisition of reading skills; in other words, these deficits represent fundamental difficulties which often manifest in reading problems, but which may still be present when reading skills appear normal, as in university students. The WFoN definition is flawed because it relies on reading difficulties as evidence of dyslexia, rather
than referring to underlying processes. The focus on reading derives from the fact that, in highly literate first world societies, reading and writing impairments are the most socially significant of the difficulties experienced by most dyslexics, given the implications for education and work. The WFoN definition has also come under heavy criticism for the inclusion of the requirement that dyslexics be of ‘adequate intelligence’: more recent research has indicated that people of sub-average IQ also show dyslexic patterns of deficit. However, it can be difficult to distinguish general deficits from deficits due to dyslexia: as such, this element of the definition remains contested. Interestingly, a similar problem applies to highly intelligent dyslexics, such as HE students: how do you demonstrate dyslexic deficits in individuals performing at extremely high levels? Most instruments have focused on comparing individual’s scores on dyslexia sensitive versus dyslexia neutral measures in order to show that, while an individual may still score highly on dyslexia sensitive measures, there is a significant difference between scores on these measures and the dyslexia neutral ones (e.g. via the ACID profile of the Weschler Intelligence Tests, also a feature of the DAST).

There is little agreement as to what constitutes the key underlying cognitive deficit(s) which dyslexics (whether or not they acquire adequate reading skills) exhibit; there is strong research in favour of each of the deficit theories discussed above. Therefore, dyslexia might be better characterised as consisting of a range of deficits, the extent of which differs across individuals: key deficit theories are complementary rather than mutually exclusive.

Some researchers have tried to assimilate key deficit theories into a single model by proposing a number of dyslexia subtypes, the most common being visual/surface dyslexia versus phonological dyslexia (Bakker, 1992; Boder, 1973; Castles & Coltheart, 1993). Wolf and Bowers (1999) argue for three subtypes of dyslexia comprising: dyslexics with phonological difficulties; those with rapid naming difficulties (which are associated with automatisation deficits); and those with both types of deficit. Although this body of research provides strong evidence that individual dyslexics show different types and levels of deficit, supporting the idea that there is no single key dyslexic deficit but rather a range of them, these variations may more accurately be conceptualised as a series of continua (see Genard et al., 1998) which may interact in different ways in individual dyslexics.

However, sub-type theories of dyslexia have not proven particularly reliable, especially when linked to diagnosis or research to develop remedial programmes. No existing screening or diagnostic tests employ subtype theories to help identify dyslexia, let alone explore individual configurations of difficulties, despite the fact that this is the primary theoretical benefit offered by subtype models; while subtype models attempt to recognise the diversity of deficits experienced by individual dyslexics (Rack, 1997), they fail to capture the true nature of these variations. They still represent a simplified understanding of the truly heterogeneous nature of dyslexia.
Existing tests focus on one or a small subset of difficulties in defining what dyslexia is and, consequently, focus on a limited spectrum of fundamental deficits, primarily Short Term Memory (STM) deficits, phonological deficits and verbal processing deficits. Until a definitive definition of dyslexia is produced, or tests become more comprehensive in terms of the types of deficits that they seek to operationalise in sub-tasks, tests will remain limited in applicability and effectiveness.

However imperfect current tests are bound to be, given the significant gaps in our understanding of the fundamental nature of dyslexia and how it manifests, it is still important to attempt to develop reliable instruments to diagnose and screen for it. Perhaps these endeavours will eventually lead to a true understanding of dyslexia. In the meantime, it is necessary to attempt to identify those with this difficulty so that they can be assisted.

**Traditional Tests**

While there are a number of reasonably reliable, well-established tests for diagnosing and screening dyslexia in the general adult population, these tests may be inappropriate for screening students, who are often able to mask their difficulties. Rack (1997) argues that these traditional dyslexia tests lack discriminatory power when used with adults of high general ability due to ceiling effects, while recent studies have demonstrated that dyslexic students use a variety of effective strategies to compensate for their difficulties (Beaton & Singleton, 1997; Warren, 1999). Separate normative scores for HE versus other adults on the Nicolson and Fawcett Dyslexia Adult Screening Test (DAST, 1998; Nicolson & Fawcett, 1997) support the conclusion that students cannot be reliably diagnosed or screened according to the same criteria as the general adult population.

The DAST, like other traditional dyslexia tests, assumes that the differences between dyslexic students and the general adult dyslexic population are purely quantitative: students are expected to evidence the same pattern of errors and difficulty across the different DAST tasks, but at higher levels than the general adult population. However, dyslexic students may compensate so effectively for their difficulties that they perform at ‘normal’ levels (even when task difficulty is increased) on tasks which are useful for identifying dyslexia in the general adult population. Therefore, the profile of difficulties that dyslexic students exhibit may be qualitatively (as well as quantitatively) different from that of the general adult dyslexic population (Beaton & Singleton, 1997); specifically designed tasks, addressing dyslexic students’ high ability and highly developed compensatory strategies, may be needed.

Interestingly, while the DAST does examine areas of individual weakness (by comparing individuals’ scores on different sub-tests), it does not attempt to
examine qualitative differences. Indeed, in their 1997 article on using the DAST to diagnose dyslexic students, Nicolson and Fawcett demonstrate that the measure failed to identify a particularly intelligent student who had developed strong coping strategies. Although they introduced an additional sub-test, this focused on identifying particularly high general ability, rather than developing a new sub-test that might be sensitive to dyslexic deficits even in highly able individuals with advanced compensation strategies at their disposal.

Dyslexia screening in HE usually involves a dyslexia sensitive measure: an instrument which can reliably indicate whether or not an individual is dyslexic by distinguishing between ‘dyslexic’ and ‘non-dyslexic’ results (i.e. it is sensitive to the presence of dyslexia markers in an individual’s results). The screening test is often accompanied by an informal interview with disability support staff; the latter goes some distance towards addressing this issue of qualitative differences.

Few studies have investigated the cognitive profile of dyslexic students, thus little information is available to examine the nature of differences between high-achieving dyslexics and other adult dyslexics. Most of the relevant studies are based on anecdotal evidence or case studies (Fink, 1998; Holmes & Standish, 1996), while quantitative studies of dyslexic adults, often employing a student sample, usually focus on one or two specific cognitive tasks (Gallagher et al., 1996; Gang & Siegel, 2002; Watson & Brown, 1992).

Hatcher et al. (2002) conducted a large-scale quantitative study, involving a wide range of tasks, to investigate which were the most effective discriminators of dyslexia in the student population. From this research, they compiled a reliable, short-form screening test, comprising non-word reading, writing speed and short term memory tasks.

However, like DAST, Hatcher et al.’s test requires expert administration, though it is not as time consuming as DAST. Although the DAST manual indicates that administration takes approximately 30 minutes, Bodenham (2000) reports that administrators require 45 minutes (administration) plus 30-45 minutes (scoring and interpretation of results). Therefore, although the DAST and Hatcher et al. tests are targeted specifically at the HE population, both instruments are resource-intensive with regard to highly-trained staff and/or time, precluding their use for widespread screening.

**Computer-based Tests**

Computerised screening provides an effective solution to this issue. Although disability support staff must explain test results and counsel students on further action, using computers for test administration and scoring results in
significant work-hour savings for highly-trained staff and, consequently, significant monetary savings (Singleton, 2004). Other advantages of computer-based assessment (CBA) include: consistent administration with no margin for bias (Bocij & Greasley, 1999); reduced test anxiety, especially in disabled users (Weisband & Keisler, 1996; Wise, 1999); increased enjoyment (Russell, 1999); and greater flexibility (Holder & Gibson, 2000). Although differences in computer literacy across users may bias CBA results, a well-designed program can minimise these effects. Current technical limitations present a more significant disadvantage; voice recognition programs require training before results are accurate, so neither DAST nor Hatcher et al.’s screening test can be effectively computerised (two of four Hatcher et al. tasks, and six of eleven DAST tasks require a spoken response).

Currently, three computerised dyslexia screening tests for adults are available: Lucid Adult Dyslexia Screening (LADS) (Singleton et al., 2002b), Instines (Teare, 2000) and QuickScan (Pico, 1998). With no peer-reviewed scientific studies currently published to support claims of a 98% reliability rate and no information provided concerning the criteria used to classify users as dyslexic/non-dyslexic, Instines’ reliability and validity are uncertain. QuickScan, a 110 item self-report questionnaire claiming 95% accuracy, is a subjective measure not sufficient as a stand-alone screening test since honesty and self-presentation are likely to exert a strong bias on results.

LADS is an adaptive test involving: (non)word construction, digit span, and word recognition. A non-verbal reasoning task is included, as the discrepancy between performance on dyslexia sensitive tasks versus tasks tapping unaffected skills, may ‘increase the accuracy of detection of dyslexia in bright, well-compensated adults’ (Singleton et al., 2002a: 7).

In Singleton et al.’s (2002a) LADS validation study of 2 universities, 3 further education colleges and 3 basic skills centres, highly significant differences (at the 0.001 level) were found between 71 dyslexic and 69 non-dyslexic students on all sub-tasks and on the combined LADS score. In a second study, involving 19 dyslexic and 19 non-dyslexic university students, matched on Weschler Adult Intelligence test scores, a significant difference (at the 0.05 level) was found between Word Recognition, Word Construction and LADS composite scores of dyslexic versus non-dyslexic individuals. However, the drop in significance levels between the two studies indicates that dyslexics and non-dyslexics are less easily distinguished in HE.

T-test analysis of the data for the Word Recognition and Word Construction tasks (Singleton et al., 2002a) revealed no significant difference between the scores of the non-dyslexics in Study 1 and Study 2, though a highly significant difference (at the 0.01 level) was found between the dyslexics. Thus the differences between dyslexic university students (Study 2) versus
Study 1 students (from a variety of institutions), reached a higher level of significance than the differences found between dyslexic and non-dyslexic university students in Study 2: it was easier to discern whether a student was from Study 1 or 2 (whether a student was at university or not) than whether a university student was dyslexic.

Mean scores were 5.6 on Word Recognition and 6.04 on Word Construction for Study 1 dyslexics (standard deviations were 2.27 and 2.43 respectively), but 4.05 and 4 for Study 2 dyslexics (standard deviations were 1.78 and 2.11 respectively), showing that the Study 2 university dyslexic students did not demonstrate less pronounced score deficits than their Study 1 counterparts. Indeed, given that the non-dyslexic mean scores in Study 2 were 2.37 and 2.11 (with standard deviations of 1.42 and 1.56), the ‘gap’ between dyslexic and non-dyslexic scores was relatively small: indeed, on both sub-tests the mean dyslexic scores were within one standard deviation of the non-dyslexic scores. Interestingly, the score gap between Study 1 and Study 2 dyslexics was roughly as big as the score gap between Study 2 dyslexics and non-dyslexics. This supports the conclusion reached in relation to significance levels: LADS has lower discriminatory power when used to screen dyslexia HE students. In effect, it demonstrates whether a student is at university or not approximately as effectively as distinguished dyslexic and non-dyslexic university students.

Interestingly, reliability rates are not given for Study 2. It is likely that these will be lower than for Study 1 (92%) and so may fall below the established minimum 90% reliability-rate criterion for screening tests (Salvia & Yssledyke, 1978). In other words, since LADS has less discriminatory power for HE students and its reliability is usually only 92% (perilously close to the 90% minimum), it is likely that reliability is less than 90% when the test is used to screen university students: thus at least 1 in 10 university students is probably incorrectly identified (either as dyslexic or as non-dyslexic).

There is compelling evidence that, although LADS is highly appropriate for the general adult population, it is less appropriate for HE. This supports the argument that university dyslexics have unique screening needs, requiring a specifically targeted test, which should be computer-based to allow widespread use.

Conclusion

There is an urgent need for new research to address the specific diagnostic challenges of the HE population so that an effective and reliable dyslexia screening test can be designed and implemented. Although dyslexia tests are hampered by the lack of agreement over what dyslexia is – making it impossible to operationalise a single definition in suitable sub-tasks – this is a gap in provision which can and should be filled. Given the recent legislative measures, especially via the Disability Discrimination Act, to ensure that all
educational institutions provide reasonable adjustments to allow students with disabilities (of which dyslexia is the most common) to study without disadvantage compared to non-disabled students, universities will welcome such a test, but only if it can be made available to all students at a reasonable cost: this will not be possible unless the test is computerised. At present, there is no screening test for dyslexia that is suitable for the HE population that could be implemented in a computer-based format to allow all students to be screened easily and cost-effectively. Until such a test becomes available, unidentified dyslexic students will continue to struggle through higher education or drop out due to lack of appropriate support.
References


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