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The adaptation of an adult group screening test for dyslexia into Finland-Swedish: Normative data for university students and the effects of language background on test performance

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We present a Finland-Swedish adaptation of the Sweden-Swedish group screening test for dyslexia for adults and young adults DUVAN™ (Lundberg & Wolff, 2003) together with normative data from 143 Finland-Swedish university students. The test is based on the widely held phonological deficit hypothesis of dyslexia and consists of a self-report and five subtests tapping phonological working memory, phonological representation, phonological awareness, and orthographic skill. We describe the test adaptation procedure and show that the internal reliability of the new test version is comparable to the original one. Our results indicate that the language background (Swedish, Finnish, early simultaneous Swedish-Finnish bilingualism) should be taken into account when interpreting the results on the Finland-Swedish DUVAN test. We show that the FS-DUVAN differentiates a group of students with dyslexia diagnosis from normals, and that a low performance on the FS-DUVAN correlates with a positive self-report on familial dyslexia and with a history of special education in school. Finally, we analyze the sensitivity and specificity of the FS-DUVAN for dyslexia among university students.

Key words: Dyslexia, screening test, higher education, bilingualism, test adaptation.

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INTRODUCTION

In modern society, even mild reading and writing problems can significantly hamper attainment of personal, educational and vocational goals. The etiology of these problems varies, but as far as specific developmental reading and writing difficulties (dyslexia) are concerned, a common core appears to lie in weak phonological processing (e.g., Frith, 1997; Høien & Lundberg, 2000; Lundberg, 1999; Lyon, Shaywitz, & Shaywitz, 2003; Reid & Fawcett, 2004; Snowling, 2000; Stanovich, 1988; Vellutino, Fletcher, Snowling, & Scanlon, 2004). To address these problems, one needs easily administrated and sensitive tests that can be used to identify affected individuals at different educational stages. Several screening tests exist for this purpose: e.g., the Dyslexia Early Screening Test, DEST (Nicolson & Fawcett, 1996), the Dyslexia Screening Test, DST, (Nicolson & Fawcett, 1998), and the Dyslexia Adult Screening Test, DAST (Fawcett & Nicolson, 1998), to name three related tests for English speakers of various ages.

One recent test aimed mainly at the upper secondary school level is the Sweden-Swedish DUVAN™ test, a dyslexia group screening test for adults and young adults (Lundberg & Wolff, 2003; Wolff & Lundberg, 2003). It is strongly anchored to the phonological deficit hypothesis of dyslexia and taps phonological awareness, quality of phonological representations, as well as phonological working memory function and orthographic skill. It also includes a self-report questionnaire on dyslexic symptoms and reading interests and habits.

Here we present a Finland-Swedish version of the DUVAN™ test (the FS-DUVAN), adopted for use among Swedish speakers in Finland. Because of cultural and linguistic differences between Finland and Sweden (see e.g., Garlén, 1988; Niemi, 1982; Rontu, 2005; Sjöholm, 2004; Tandefelt, 2001), the original test had to be modified. We will describe the test adaptations and provide normative data from a sample of 117 normal first-year university students and 26 students with a previous diagnosis of dyslexia or possible dyslexia at the Åbo Akademi University, the only Swedish-speaking university in Finland.

The two official languages in Finland are Finnish and Swedish (for further information see e.g., Tandefelt, 2001). Given the minority language status of Swedish in Finland and, hence, the bilingual background of many Åbo Akademi students, we were also able to examine possible effects of language background on the FS-DUVAN performance. The issue of multilingualism/bilingualism and dyslexia is extensively discussed in Peer and Reid (2000), where, for instance, Frost (p. 133) draws attention to the problem of distinguishing between difficulties due to limited L2 knowledge and those due to dyslexia. Needless to say, the level of Swedish language proficiency of the Åbo Akademi students varies between individuals, but the average level is high. Nevertheless, it is pointed out that the mother tongue should

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be taken into account when testing for dyslexic weaknesses in the phonological system (Everatt, 2005; Lundberg & Wolff, 2003), as should bilingualism (e.g., Everatt, 2005; Everatt, Smythe, Ocampo, & Gyarmathy, 2004; Peer & Reid, 2000).

Following a comparison of the performance on the FS-DUVAN by the normal participants with different language backgrounds, we will compare the FS-DUVAN performance of the normal groups to that of a small group of university students with a previous diagnosis of possible dyslexia. Then we investigate the performance on the FS-DUVAN in relation to the participants' self-report of dyslexia in the family and background of special education in school, and finally we explore cut-off scores for our data.

The DUVAN™ Dyslexia Group Screening Test

Besides being cost-efficient, group screening for dyslexia enables the inclusion of individuals who may not be aware of their reading and writing problems and who may otherwise remain undiagnosed. This feature is a strength particularly at the highest educational levels where one expects to encounter mostly mild dyslexic deficits. The DUVAN™ attempts to meet these needs for Sweden-Swedish adults and young adults with its group testing format and rather short (approx. 40 minutes) administration time (Wolff & Lundberg, 2003). Being a group test, all tasks in the DUVAN™ are accomplished by paper and pencil.

The DUVAN™ consists of five subtests and a self-report questionnaire, which are briefly presented below. For a detailed description, see Lundberg and Wolff (2003), and Wolff and Lundberg (2003). Part A is the self-report measuring reading interest and habits, and comprising questions directly related to dyslexia (20 statements on a four-point Likert scale). Subtest B taps the phonological working memory through six tasks in increasing difficulty. The participants hear a consonant that is immediately followed by a statement and question (e.g., "The letter R. Ducks can swim. Can they climb trees?"). They answer the question by showing a yes/no sign, then hear a new letter-statement-question set from tape and show their answer, and after having heard and answered 2, 3, or 4 such sets, they write down the letters. The test is strictly time-constrained. In subtest C, the quality of phonological representations and to some extent phonological working memory are tested in a multiple-choice vocabulary task, where the appropriate synonym is to be marked among two phonologically confusable alternatives (e.g., "killing: excursion, execution, exclusion") (untimed). In subtest D, phonological awareness and working memory are measured in a reversed spoonerism task: the participants hear two word pairs from tape (mixed real words and non-words, e.g., "mound roon"), exchange the initial sounds quietly to themselves, and mark the one picture among three that corresponds to the new word or word pair ("round moon"). In subtest E, phonological awareness and phonological representation are further tested in a two-minute phonological choice task tapping silent auditory recognition of a word. Among three written non-words, the one word that sounds like a real Swedish word and carries meaning is to be marked. In the final subtest F, the procedure is the same as in subtest E, except that the test calls for detailed orthographic processing and the participants mark the correctly spelled Swedish word between two distracters.

The DUVAN™ falls back on previous research and on extensive practical and theoretical work done by its constructors. Following several pilot tests with dyslexic and non-dyslexic persons and a cross-validation with a standardized decoding test, Wordchains (Jacobson, 2001), the final data for the standardization of the Sweden-Swedish DUVAN™ comprise 271 participants, of whom 49 were previously formally diagnosed or classified by their teachers as dyslexics (mean age 22.5 years, SD = 8.9). The test proved to be sensitive in distinguishing between the dyslexics and the non-dyslexics on each subtest and on the summative score. Logistic regression analyses showed a correct classification of 96% of the cases indicating a high discrimination rate. Both internal and test-retest reliability of the DUVAN™ was quite high. The DUVAN™ can thus be considered a valid and reliable dyslexia screening instrument for adult and young adult Swedish speakers (Lundberg & Wolff, 2003). Given this, we undertook to adopt the test to meet Finland-Swedish diagnostic needs (cf. e.g., Opetusministeriö, 1999).

MATERIALS AND METHODS

Construction of the Finland-Swedish Version of the DUVAN™ Test (FS-DUVAN)

From the outset, the aim was to make as few changes in the DUVAN™ as possible. While the overall test structure was maintained, a number of details were, nevertheless, changed due to cultural, linguistic and technical reasons. The changes were based on a detailed analysis of each subtest and extensive piloting with Finland-Swedish individuals.

The cultural changes either concerned the names of institutions and of geographical places or were motivated by the bilingual language situation in Finland, which is reflected in the school system and in television broadcasting, for instance (cf. Rontu, 2005; Sjöholm, 2004; Tandefelt, 2001). The linguistic changes, for their part, were motivated by cross-language differences between Sweden-Swedish and Finland-Swedish (cf. Garlén, 1988; Niemi, 1982; Vihanta, Leinonen, & Pitkänen, 1990) or by more general linguistic concerns and were made at phonological, lexical and syntactic level. The technical changes concerned primarily insertions such as adding written instructions in the answering booklet as a complement to the oral instructions. Other changes included adding a column for self-evaluation regarding whether the participant had guessed or knew a particular word, for instance, and space for a brief comment on strategies used. Below we go through the changes subtest by subtest.[1]

Self-Report (Subtest A). The Sweden-Swedish self-report consists of 20 questions concerning reading interest and habits, and dyslexia. Alterations were made to eight of them. Given the language situation in Finland and the bilingual nature of many of our subjects, a multiple reading of the term "language" and "foreign language"

could be anticipated in six questions. Consequently, these questions were clarified by adding "the mother tongue", "the second domestic language", or "other foreign languages" to them in order to avoid ambiguity. Further changes concerned one abbreviation and one name of an institution, which are neither transparent nor used in Finland. One question was rephrased in order to adjust it to Finland-Swedish. To reflect developments in media, a question of reading in the Internet was added in analogy to a question that deals with non-virtual library visits,[2] and "television" was complemented by "the movies". On request from a pilot group, a question about reading was specified by inserting "course books" for disambiguation.

With regard to scoring, in the original DUVAN™ the total points for the 15 Dyslexia-related questions are 60 and for the five questions on Reading interest 20. In the FS-DUVAN the corresponding Dyslexia-related points are 60 when only including points related to the mother tongue (15 questions). When including "the second domestic language" and "foreign languages" the maximum points add up to 92 (altogether 23 questions). For the Reading interest part, the maximum points are 24, including the question about reading on the Internet (six questions).

Working Memory (Subtest B). In this subtest, the maintenance of letter series in short-term memory is challenged by intermittent questions. The questions should be very simple to answer (Lundberg & Wolff, 2003). Accordingly at least one alteration was made in 14 of the 18 statement-question pairs, as well as in two of the examples. These included phonetic changes (e.g. a change of the pronunciation of the third-person plural personal pronoun, subject form /dɔm/ to /dɪ, de/), geographical changes (changes in place names), lexical changes (exchanging to some Finland-Swedish idiosyncrasies), and syntactic changes (minimizing some potential ambiguities). As this is an auditory task, the changes called for a new recording. A new recording was also motivated by differences between the Finland-Swedish and the Sweden-Swedish pronunciation, stress and intonation patterns (cf. Garlén, 1988; Vihanta *et al.*, 1990). The recruited reader had a Finland-Swedish geographically neutral voice of female gender. The scoring was not altered (total points 36).

Vocabulary (Subtest C). This subtest requires the selection of the correct synonym for a target word among two phonologically confusable alternatives. Very few changes were made to this subtest. In the answering booklet, a column was added for the subjects to mark whether they knew the answer (or found the answer through exclusion) or guessed the answer for each target word. This was added to enable a rough estimate of the proportion of guessing. One distracter item was mistakenly used two times in the original; in one instance it was therefore replaced with another word. The scoring was unaltered (total points 14).

Reversed Spoonerisms (Subtest D). This subtest is an audio-visual task that involves playing with an exchange of initial sounds. Here the main change involved a new recording, thus adjusting pronunciation, intonation and stress to Finland-Swedish. This was needed as, for example, the Sweden-Swedish pronunciation of "tjock" (*fat*) /ɧɔk/ was understood as "chock" (*shock*) /ʃɔk/ and not as *fat* /tʃɔk/ by the Finland-Swedish participants in the first piloting tests. The new recording also reflected the Finland-Swedish speech rate, which is generally seen as slower than the Sweden-Swedish one due to, for instance, less reduction and different stress patterns (Vihanta *et al.*, 1990). The inter-stimulus intervals, however, were kept the same. Additionally, one example word pair was also changed, as one of the words was repeated within the test itself. The scoring was unchanged (total points 24).

Phonological Choice (Subtest E). In this speeded subtest, the participants mark the non-word among three that sounds like a real word. Piloting revealed that some of the target words were not recognized as real words by Finland-Swedish persons even when the task was done under no time constraints. This was due to the differences in pronunciation between Sweden-Swedish and Finland-Swedish (e.g. <ä> in *lässen* was decoded as /æ/ and not as /e/, which prompted a change to *lessen* "ledsen" (sad), similarly words with the tje-/sje-sound, e.g. <ch> *tjangs* /tʃaŋs/ was changed to *sjans* /ʃans/ "chans" (chance)). Moreover, some distracters, which were not to sound like real words, turned out to be real words in written and/or in spoken form. These were foreign lexical words (e.g., **kan[n]st* (German), *him* (English), *jaksa* (Finnish)), correctly spelled Swedish words and Swedish sounding words that are part of the spoken vocabulary (e.g., *jet*), Finland-Swedish dialect words (e.g., *pällo*), and proper names (e.g., *Palsa, Danti*). Necessary changes were thus made. Also *tera* and *arp*, although not necessarily part of everyday Swedish language, were changed to proper non-words. A few systematic changes in consonant clusters were also made to better conform to the phonological structure of Finland-Swedish. Finally, two words that appeared in both subtest E and F were replaced in E. All in all, 68 of the 180 items were replaced or in some way altered. The total points for this subtest remained 60 as in the original version.

Orthographic Choice (Subtest F). This subtest targets orthographic knowledge. Under time constraints, the correctly spelled [Swedish] word is to be selected between two orthographically confusable alternatives. One of the changes to this subtest concerned the instructions. In the original ones, it is not specified that the target words are real words of the Swedish language. Some distracters that were included as common Swedish misspellings, however, matched correct spellings of English words (e.g., *doctor, send*). "Swedish" was, therefore, inserted for clarity in the FS-DUVAN instructions. (A similar insertion of "Swedish" was subsequently also made in subtest E). Where the first word in a line was a distracter corresponding to a correctly spelled word in another language, the word order was changed (two instances). Consistent with alterations made to the other subtests, alterations were made to distracters where the Finland-Swedish pronunciation differed from the Sweden-Swedish one (e.g. <ä> in *traditionäll* was understood as /æ/ and not /e/ and <ä> was exchanged). Exchanges were also made concerning four words that have two accepted spellings according to both Sweden-Swedish and Finland-Swedish normative rules (*spagettil/spaghetti; sprej/spray; camouflage/kamouflage; cigarrett/cigarette*; SAOL 1998). Unfortunately, one of the four was not detected until after the first data collection session, when it was immediately deleted from the answering booklet, but not replaced. Finally, a word that appeared two times in the original subtest was substituted with another word in one of the instances. In all, 45 of the 300 words were altered or replaced, and additionally, the word order was changed in two cases. The maximal number of words and, thus, points was reduced from 100 to 99. As the task is constructed so that no one should manage to finish all the words within the given time limit, the reduction of one item should not affect the functionality of the subtest.

Participants

The participants in the present study consisted of two groups of university students (Table 1): a randomly selected sample, and a small sample of volunteers with dyslexia diagnosis. The random selection yielded a target group of 341 individuals. This is 46% of the altogether 743 first-year students who had been registered in the Åbo Akademi University database as full-time students with Swedish or Finnish as their mother tongue (L1) in the fall of 2003. Of the 341 selected students[3] (66% females; 86% L1 Swedish; 83% freshmen),[4] 129 volunteered to participate and completed the test.

Table 1. *Descriptive statistics for the Finland-Swedish participants in the FS-DUVAN*

	Random sample (n = 129)	Volunteered sample with dyslexia diagnosis (n = 14)
Gender female/male	93/36	11/3
Age Mean (*SD*, range)	20.58 (3.51, 18–45)	26.50 (5.88, 20–44)
Mother tongue Swedish/Finnish	108/21	14/ –
Matriculation Examination[a]		
Mean (*SD*, range)	4.87 (0.85, 3.00–6.71)	4.69 (1.16, 3.00–7.00)

[a] The grades are 1–7 (1 = fail, 7 = pass with distinction). Most, but not all university students have taken the Matriculation Examination (here 125/129 of the normative sample and 14/14 of the dyslexia sample had taken it).

In addition to this sample, 14 students at Åbo Akademi University who all had previously been diagnosed with dyslexia by a psychologist or by a teacher voluntarily signed up for the test (11 females; all L1 Swedish; on the average 4–6 years of university studies). These students were recruited from different sources: through the Student Union, by university newsletters, and via referrals from the Centre for Language and Communication at the university. The testing took place in the fall of 2003 and in the winter of 2004.

In order to compare the two study groups on relevant background variables, we conducted statistical analyses on gender, the L1, the grade in the Matriculation Examination[5] and on age. The groups did not differ on gender distribution (Fisher's Exact Test $p = 0.76$) or on L1 (Fisher's Exact Test $p = 0.22$). Furthermore, there was no significant difference between the two groups with regard to the mean grade in the Matriculation Examination (Mann-Whitney U = 759.00, N1 = 125, N2 = 14, $p = 0.42$). The only statistically significant difference was found on age, which was to be expected. The volunteers with dyslexia diagnosis were somewhat older, mean 26.50 (SD 5.88), than the randomly selected sample of new students, mean 20.58 (SD 3.51), $t(14) = -3.64$, $p = 0.003$, equal variances not assumed.

Test procedure

The FS-DUVAN was administered at 29 occasions, each with 1–16 participants (the random sample and the additional volunteers with dyslexia diagnosis), depending on the students' possibilities to participate and on the localities available at the three university sites, Åbo (Turku), Vasa and Jakobstad that are geographically located wide apart. The test was administered by the same test leader (the first author) at all occasions. Prior to the test situation, each participant of the randomly selected target group received written information about the test and the procedures through letter and/or e-mail. The dyslexia group received initial information distributed by the Student Union and by university newsletters, as well as from the Centre for Language and Communication at the Åbo Akademi University. A web page was also set up with practical information about the test and the test situation.

At the beginning of each test session, general information about the test and the test procedure was repeated and each participant signed a written consent for the data to be used for research purposes. Moreover, each subtest was preceded by an example, and throughout the test, opportunities were given for the participants to ask for clarifications. The subtests were administered in the order the tests were presented above. The time for the completion of the screening test was approximately 40 minutes. Preceding the screening test, an extensive questionnaire was administered, covering language background, language studies, and a subjective evaluation of one's language proficiency, as well as questions on dyslexia in the family and on one's history of special education in school. The total length of each session therefore varied between 55 and 70 minutes.

Data encoding

The test results and the background data were fed into SPSS for Windows package 13.0. The coding of the answers followed a strict key to ensure reliability. The first author and two student helpers, who assisted in the coding, met regularly to discuss any problematic matters, and random checks were made across the data to verify consistency and correctness of the coding procedure.

Analysis of subject loss

The participation rate for the randomly selected target group was 37.8% ($n = 129$). This prompted a closer look at subject loss in order to evaluate the generalizability of the results from the normative sample. Table 2 presents data on the tested (TS) against the not tested (NTS) subjects in the original randomly selected target group of 341 students divided by study region.

When comparing the TS and the NTS groups, a tendency towards more women than men participating was observed, but this did not quite reach statistical significance ($Chi^2 = 3.452$, df = 1, $p = 0.06$). Concerning age, a two-way between-subjects ANOVA with group (TS vs. NTS) and study region (Åbo vs. Vasa/Jakobstad) as the independent factors was performed. It showed significant main effects for both group and study region: the NTS students were somewhat older than the TS students ($F(1, 337 = 11.0$, $p = 0.001$), and the same was true for the Vasa/Jakobstad students when compared to the Åbo students ($F(1, 337) = 6.65$, $p = 0.01$). Moreover, there was a significant interaction between group and study region ($F(1, 337) = 5.49$, $p = 0.023$), indicating that a significantly larger proportion of the older NTS participants came from Vasa/Jakobstad than from Åbo.

Reasons for the lower participation rate and the participants' higher age in the Vasa/Jakobstad sample are probably related to the faculties (the Faculty of Education and the Faculty of Social and Caring Sciences) and the study programs they offer. Some of the study programs generally attract also older students who return to university to study towards a diploma after having gathered work experience, and these faculties also offer a number of distance study programs. An examination of the Vasa-Jakobstad sample proved that students in distance programs were included in the original random sample of our data. The relatively larger subject loss among the older students should not, however, significantly hamper the data as our focus was on freshmen. The vast majority of the

Table 2. *Descriptive statistics for the tested vs. not tested individuals in the original randomly selected target group per study region*

	Tested (n = 129)		Not tested (n = 212)	
	Åbo (n = 99)	Vasa/Jakobstad (n = 30)	Åbo (n = 128)	Vasa/Jakobstad (n = 84)
Gender female/male	67/32	26/4	72/56	60/24
Age Mean (*SD*, range)	20.63 (2.96, 19–38)	20.83 (4.81, 19–45)	21.34 (4.40, 19–51)	24.71 (8.66, 19–50)
Mother tongue				
Swedish/Finnish	79/20	29/1	103/25	83/1
Matriculation Examination[a]				
Mean (*SD*, range)	5.01 (0.86, 3.00–6.71)	4.39 (0.65, 3.20–5.67)	4.91 (0.84, 3.20–6.67)	4.23 (0.78, 2.40–6.00)

[a] 97/99 resp. 28/30 of the tested sample and 122/128 resp. 74/84 of the not tested sample had taken the Matriculation Examination.

Table 3. *Internal reliability measures of the FS-DUVAN (*n = *143) and the DUVAN™ (*n = *271)*

	Cronbach's alpha		Mean inter-item correlations	
Subtest (Number of items)	FS-DUVAN	DUVAN™	FS-DUVAN	DUVAN™
A Self-Report Dyslexia in L1 (15)	0.88	0.91	0.30	0.40
A Self-Report Dyslexia in L1, L2, FL (23)	0.91	–	0.30	–
A Self-Report Reading interest (5 + 1)	0.85	0.89	0.50	0.62
B Working Memory (18)	0.78	0.78	0.16	0.38
C Vocabulary (14)	0.66	0.68	0.12	0.13
D Reversed Spoonerisms (24)	0.78	0.81	0.13	0.15

Note: The data for the DUVAN™ are from Lundberg and Wolff (2003, p. 44).

students admitted to university are enrolled directly after they graduate from the upper secondary school, generally at the age of about 19.

Concerning L1 (Swedish or Finnish), no significant difference was found between the TS and the NTS groups ($Chi^2 = 1.09$, df = 1, $p = 0.30$). The subjects reporting Finnish as their L1 were further analyzed to reveal whether those Finnish speakers who did not participate possibly had significantly poorer knowledge of Swedish than those who participated. No evidence for such a difference was found. Group comparisons of the grades in the Matriculation Examination of the Second Domestic Language Test (which is in Swedish for Finnish speakers) and of the scores in the University Swedish language entrance examination for applicants who have a Finnish schooling background[6] were non-significant (the Second Domestic Language Test: U = 224.50, N1 = 20 Finnish TS, N2 = 25 Finnish NTS, $p = 0.53$; Swedish language entrance examination $t(32) < 1$.

The analysis of the average grade in the Matriculation Examination revealed a statistically significant group difference: the TS had an average grade of 4.87 (SD 0.85) and the NTS of 4.67 (SD 0.88) (U = 10,505.00, N1 = 125, N2 = 196, $p = 0.03$). This difference was followed up by looking at scores of specific tests in the Matriculation Examination with possible relevance for a specific difficulty with reading and writing (the Mother Tongue Test, the Second Domestic Language Test, the First Foreign Language Test, the General Studies Test). The General Studies Test was the only one showing a statistically significant difference. The NTS group had significantly lower grades, on average 4.89 (SD 1.27) for the TS and 4.51 (SD 1.44) for the NTS (U = 9,344.00, N1 = 119, N2 = 186, $p = 0.02$). An analysis of the Final School Record from the upper secondary school (available for part of the students only) showed no significant group differences on the average grade: TS mean 8.12 (SD 0.85), NTS mean 8.02 (SD 0.89), $t(193) < 1$, nor on a composite average grade for general studies (history, geography, biology and religion): TS mean 8.08 (SD 1.05), NTS mean 8.20 (SD 2.16), $t(151) < 1$.[7]

RESULTS

Reliability of the FS-DUVAN subtests

To estimate the internal consistency of the FS-DUVAN subtests, the same measures were applied as those used in the DUVAN™, namely Cronbach's alpha and mean inter-item correlations (Lundberg & Wolff, 2003). Overall, the Finland-Swedish test has slightly lower values than its Sweden-Swedish counterpart, most remarkably for the Working Memory Test. However, the Cronbach's alpha values for the FS-DUVAN subtests closely correspond to those of the Sweden-Swedish test with coefficients ranging between 0.66 and 0.91, and 0.68 and 0.91, respectively (Table 3). Moreover, the same subtests had the highest vs. lowest alpha values in both the Sweden-Swedish test and the Finland-Swedish test. The inter-item correlations of the FS-DUVAN and the DUVAN™ show values from 0.12 to 0.50 and 0.13 to 0.62, respectively, mainly falling in the range of 0.15–0.50 as recommended by Clark and Watson (1995).

Normative data on the FS-DUVAN

In order to obtain normative data, the 129 randomly selected volunteering participants were divided into two groups: normal individuals (n = 117) and those who possibly suffered from dyslexia (n = 12). The classification was based strictly on the Part A Self-Report question as to whether they had previously been diagnosed with dyslexia by a psychologist

Table 4. *Performance on the FS-DUVAN by the normal sample (*n = *117) and the suspected dyslexia sample (*n = *26)*

Subtest	Normals (n = 117)			Suspected dyslexics (n = 26)			No. of items/ Max points
	Mean	*SD*	Range	Mean	*SD*	Range	
A Self-Report							
Dyslexia in L1	50.9	5.9	30–60	36.6	8.2	12–57	15/60
Dyslexia in L1, L2, FL	76.7	8.6	50–92	55.7	10.8	30–78	23/92
Reading interest	19.6	3.7	8–24	16.2	4.3	7–23	6/24
B Working Memory	34.2	2.9	25–36	30.1	6.6	14–36	6/36
C Vocabulary	10.7	2.5	4–14	11.2	2.0	8–14	14/14
D Reversed Spoonerisms	17.4	4.0	7–24	13.9	4.9	6–24	24/24
E Phonological Choice	29.7	9.1	8–51	26.6	8.4	11–50	60/60
F Orthographic Choice	60.8	17.3	30–97	45.9	15.8	11–87	99/99
Summative score[a]	203.6	30.9	131–267	164.4	29.8	114–238	– /293

[a] Not including points related to the second domestic language, to foreign languages and to reading and motivation in subtest A (Reading interest; Dyslexia in L2, FL).

or a teacher. Twelve participants responded "strongly agree" or "agree" on a four-point scale. They were included in a separate suspected dyslexia group together with the 14 volunteers with dyslexia diagnosis, who fulfilled the same Self-Report criterion. The normative data reported in Table 4 is based on the FS-DUVAN results of the 117 normal individuals. For further comparisons, the table also includes the test results of the suspected dyslexia group (n = 26).

Because of the diagnostic importance of the summative score that combines results from the subtests tapping phonological and orthographic skills, as well as scores from the self-report (Lundberg & Wolff, 2003), its relationships to three relevant background variables (age, gender and language background) were separately explored in the normal group. As to be expected, there was no correlation between the age of the normal participants and their FS-DUVAN summative score (Pearson r = –0.10, n = 117, p = 0.28). With regard to gender, women scored only slightly higher than men with a mean of 204.2 (SD 32.5) to 201.8 (SD 25.5), and the difference was not statistically significant, $t(115) < 1$. However, the group difference between those registered with L1 Swedish and those with L1 Finnish was statistically highly significant, with a mean of 210.1 (SD 28.0) for the Swedish speakers and of 172.2 (SD 25.7) for the Finnish speakers, $t(115) = 5.61$, $p < 0.001$. This difference prompted us to separately explore the FS-DUVAN performances of the participants with Swedish, Finnish, and bilingual Swedish-Finnish language background.

The effects of language background on the FS-DUVAN performance in normal individuals

For the present analysis, information from the extended language profile sheet was used to regroup the participants of the normative sample (n = 117) and those of the suspected dyslexia sample (n = 26) into participants with Swedish language background (SB), Finnish language background (FB), and bilingual Swedish-Finnish language background (BB).

The participants included in the "monolingual" Swedish and the "monolingual" Finnish groups, respectively, had grown up in an environment where the L1 of both parents was either Swedish or Finnish, and the parents and the child had used only this language in their communication until the child was at least 6 or 7 years old (i.e. until school age). Furthermore these participants had, when applicable, attended a Swedish or a Finnish kindergarten/daycare, respectively.

A bilingual was strictly defined as an early simultaneous bilingual growing up with each parent speaking his/her own L1 (Swedish and Finnish, respectively) to the child. When applicable, a bilingual participant had attended a Swedish or a Finnish language based kindergarten. He/she may have used either Swedish or Finnish or both with his/her parents. Participants with a parent or parents who had used another language than Swedish or Finnish with the child in early childhood or with a parent who did not have Swedish or Finnish as their L1 were, thus, not included in the bilingual group.

Following these criteria, 94 normals (n = 57 SB, n = 16 FB, n = 21 BB) and 22 suspected dyslexics (n = 13 SB, n = 9 BB) remained for subgroup analyses (no suspected dyslexics with FB were found in the data). Their gender distribution and mean age are presented in Table 5. The distribution of gender in the two Swedish groups and in the two bilingual groups, respectively, did not differ (normals vs. suspected dyslexics with SB, Fisher's Exact Test p = 0.32; normals vs. suspected dyslexics with BB, Fisher's Exact Test p = 1.0). The suspected dyslexics were slightly older than the normals, but this difference was not quite significant in either group (the mean age for the SB normals was 20.0 (SD 1.4) and for the SB suspected dyslexics 25.1 (SD 8.9), $t(12.1) = 2.05$, $p = 0.06$, equal variances not assumed; the mean age for the BB normals was 20.6 (SD 3.2) and for the BB suspected dyslexics 23.1 (SD 3.8), $t(28) = 1.89$, $p = 0.07$).

Prior to the group comparisons, the FS-DUVAN results of each group were checked for normality by histograms, and by

Table 5. *Descriptive statistics for the participants with Swedish language background, Finnish language background and early simultaneous Swedish-Finnish bilingual language background per normal groups (*n = *94) and suspected dyslexia groups (dys-sus) (*n = *22)*

	Language background in early childhood				
	Swedish		Finnish[a]	Swedish-Finnish	
	normal (n = 57)	dys-sus (n = 13)	normal (n = 16)	normal (n = 21)	dys-sus (n = 9)
Gender female/male	41/16	7/6	15/1	15/6	7/2
Age Mean (*SD*)	20.0 (1.4)	25.1 (8.9)	22.2 (5.5)	20.6 (3.2)	23.1 (3.8)
Range	18–24	19–45	19–38	19–33	20–31

[a] No suspected dyslexics with Finnish language background were found in the data.

the measures of skewness and kurtosis. The equality of variance between the groups was also analyzed. As only the FS-DUVAN summative score fulfilled the criteria for the use of parametric tests, the Kruskal-Wallis test and the Mann-Whitney U test were employed in the analyses of the subtest results.

FS-DUVAN results of the normals subdivided by language background. The descriptive statistics for the FS-DUVAN performance of the three subgroups of normals with different language backgrounds (Swedish, Finnish, and bilingual Swedish and Finnish) are given in Table 6. The figures indicate that the normals with SB had the highest performance throughout the test, except in the Reading interest part of the Self-Report. Furthermore, those with FB had an overall lowest performance throughout the screening test, with the exception of the Part A Self-Report. A one-way between-subjects ANOVA with the summative score as the dependent variable showed a statistically significant difference between the three normal groups ($F(2, 91) = 18.28$, $p < 0.001$). The Kruskal–Wallis tests revealed statistically significant group differences in all subtests except in Reversed Spoonerisms (D) and in the Self-Report (A), where, however, near significance was reached for the dyslexia part on the L1, cf. Table 6.

Further pairwise group analyses with Mann-Whitney U tests and Keppel's modified Bonferroni-corrected significance levels (5% alpha level = 0.008) (Keppel, 1991) showed that statistically significant differences emerged in the Working Memory task (B) and in the Orthographic Choice task (F) between the two "monolingual" groups only; in the Vocabulary task (C) and the Phonological Choice subtest (E) between the participants with FB and those with SB and BB, respectively (near statistical significance in task (C) between SB and BB). Finally, statistically significant pairwise differences were found in the summative score between the SB group and the two other groups, respectively (Tukey's post hoc test).

Comparisons of FS-DUVAN test results of the suspected dyslexics and the normals subdivided by language background

The performance of the Swedish suspected dyslexia group (dSB) and of the bilingual suspected dyslexia group (dBB) is presented in Table 7. The sample sizes are small, but in the available data the dSB (n = 13) received higher mean scores than the dBB (n = 9) in all the subtests, and in the summative score. Their mean score was 177 (SD 34.7) as opposed to 150 (SD 18.1) in the dBB group. The differences, however, reached statistical significance only in the summative score ($U = 25.50$, $p = 0.03$) and in the Self-Report Reading interest part ($U = 25.50$, $p = 0.02$), with a near statistical difference in the Self-Report Dyslexia L1 part ($U = 31.00$, $p = 0.07$) and in the Orthographic Choice test ($U = 31.00$, $p = 0.07$).[8]

In the following, we describe the performance of the dyslexic participants with Swedish language background and of those with bilingual language background separately, including statistical comparisons to the respective control group.

Participants with Swedish language background. In all subtests and on the summative score, the normal group with Swedish language background (n = 57) performed better than the corresponding suspected dyslexia group (n = 13). The mean of the summative score for the normal group was 215 (SD 27.1), and 177 (SD 34.7) for the suspected dyslexia group. The differences between the performances achieved statistical significance on the summative score ($U = 141.00$, $p = 0.001$), as well as on the Self-Report Dyslexia parts (A) (Self-Report Dyslexia in L1: $U = 96.50$, $p < 0.001$; Self-Report L1, L2, FL, Dyslexia: $U = 70.50$, $p < 0.001$), the Working Memory test (B) ($U = 207.50$, $p = 0.005$), the Phonological Choice test (E) ($U = 226.50$, $p = 0.03$), and the Orthographic Choice test (F) ($U = 217.00$, $p = 0.02$). Near statistical significance was reached in the Reading interest part of the Self-Report ($U = 253.50$, $p = 0.08$), and in the Reversed Spoonerism task (D) ($U = 244.00$, $p = 0.06$). No statistically significant difference was observed in the Vocabulary task (C).

Participants with Swedish-Finnish bilingual language background. Similarly to the two SB groups, the normal participants with bilingual language background (nBB, n = 21) performed better than the suspected dyslexia participants with bilingual language background (dBB, n = 9) on the summative score with a mean of 193 (SD 28.5) as compared to 150 (SD 18.1).

Table 6. *Performance on the FS-DUVAN test by the normals subdivided according to language background: Swedish (*n = *57), Finnish (*n = *16), and Swedish-Finnish bilinguals (*n = *16)*

	Swedish (n = 57) (SB)			Finnish (n = 16) (FB)			Bilinguals (n = 21) (BB)				Mann-Whitney U test[c] p-value		
Subtest	Mean	*SD*	Range	Mean	*SD*	Range	Mean	*SD*	Range	Kruskall-Wallis p-value	SB vs BB	SB vs FB	BB vs FB
A Self-Report													
Dyslexia L1	52.1	5.2	37–59	50.9	6.0	40–60	48.4	6.8	30–56	0.066			
Dyslexia in L1, L2, FL	77.2	8.5	53–89	77.7	8.1	63–92	74.7	9.2	51–85	0.524			
Reading interest	19.8	3.6	10–24	20.7	3.5	11–24	18.9	3.7	9–24	0.209			
B Working Memory	34.9	2.0	26–36	31.6	4.0	25–36	34.1	2.9	27–36	0.01	0.349	0.003	0.101[b]
C Vocabulary	11.6	2.1	7–14	7.9	2.2	4–12	10.2	2.0	5–13	<0.001	0.009	<0.001	0.003[b]
D Reversed Spoonerisms	17.4	4.1	7–24	16.3	4.1	9–22	17.3	3.6	10–24	0.628			
E Phonological Choice	32.6	7.7	17–51	16.9	5.3	8–28	28.9	7.1	20–40	<0.001	0.069	<0.001	<0.001[b]
F Orthographic Choice	66.2	16.8	32–97	46.9	14.1	30–77	54.6	15.6	31–89	<0.001	0.011	<0.001	0.089[b]
Summative score[a]	214.7	27.1	158–267	170.5	24	131–208	193.4	28.5	142–252	<0.001[d]	0.024[e]	<0.001[e]	0.094[e]

[a] Not including points related to the second domestic language, to foreign languages and to reading and motivation in subtest A (Reading interest; Dyslexia in L2, FL).
[b] Exact Sig. [2*(1-tailed Sig.)], not corrected for ties.
[c] Pairwise comparisons are calculated only for those tests where the main effect for group is statistically significant. Mann-Whitney U tests with Keppel's modified Bonferroni-corrected significance levels (5% alpha level = 0.008).
[d] Based on one-way ANOVA.
[e] Based on Tukey's test.

Table 7. *Performance on the FS-DUVAN by the suspected dyslexics subdivided according to language background: Swedish (*n = *13) and Swedish-Finnish bilinguals (*n = *9)*

	Swedish ($n = 13$)			Bilingual ($n = 9$)		
	Mean	*SD*	Range	Mean	*SD*	Range
A Self-Report						
Dyslexia in L1	39.5	9.3	26–57	32.9	6.9	21–42
Dyslexia in L1, L2, FL	58.8	11.5	35–78	50.6	10.8	30–62
Reading interest	18.1	3.5	10–23	14.0	4.2	7–19
B Working Memory	31.5	5.1	22–36	29.2	6.7	19–36
C Vocabulary	11.6	1.9	8–14	10.4	1.9	8–14
D Reversed Spoonerisms	14.5	5.3	6–24	12.2	3.9	7–19
E Phonological Choice	28.0	8.9	14–50	24.3	9.1	11–37
F Orthographic Choice	51.7	19.8	11–87	40.6	7.9	29–53
Summative score[a]	176.8	34.7	114–238	149.7	18.1	127–177

[a] Not including points related to the second domestic language, to foreign languages and to reading and motivation in subtest A (Reading interest; Dyslexia in L2, FL).

Moreover, they performed better on all subtests but one, the Vocabulary test (C), in which the dBB had a slightly higher mean score. The differences reached statistical significance in all the Self-Report parts (A) (Self-Report Dyslexia in L1: $U = 11.00$, $p < 0.001$; Self-Report L1, L2, FL, Dyslexia: $U = 9.00$, $p < 0.001$; Self-Report Reading interest: $U = 32.50$, $p = 0.004$), in the Reversed Spoonerism task (D) ($U = 33.50$, $p = 0.004$), and in the Orthographic Choice test (F) ($U = 38.00$, $p = 0.009$), as well as in the summative score ($U = 17.00$, $p < 0.001$). The performances on the Working Memory task (B) reached only near statistical significance ($U = 53.50$, $p = 0.06$), and no statistically significant difference was observed in the Vocabulary task (C) or in the Phonological Choice task (E).[8]

The relationship of FS-DUVAN results with familial dyslexia and special education background

Questions on dyslexia in the family and on special education received in school were included in the same profile questionnaire that was used to outline the language background of the altogether 143 participants. We compared the relationship between the FS-DUVAN summative score of those who reported familial dyslexia ($n = 37$) with the summative score of those who reported no dyslexia in the family ($n = 32$). In a separate analysis, we additionally compared the summative score of those who had received special education in school ($n = 19$) with that of those who had not ($n = 114$).

In line with previous studies that have established a connection between dyslexia and heredity and the persistence of dyslexic difficulties into adulthood (cf. e.g., Høien & Lundberg, 2000; Lyytinen *et al*., 2004; Shaywitz *et al*., 1999; Snowling, 2000; Snowling, Gallagher & Frith, 2003; Stein, 2004; Svensson, 2003; Taipale *et a*l., 2003), our analyses revealed that those with dyslexia in the family and those who had received special education in school performed statistically significantly poorer on the FS-DUVAN. The participants with familial dyslexia had a mean summative score of 181.54 (SD 33.8), while the average summative score was 213.38 (SD 24.4) for those who reported no dyslexia in their family, $t(67) = 4.42$, $p < 0.001$. However, as many as 50.7% of those who answered the question on familiar dyslexia ($n = 71$ of 140, three with no answer) replied that they did not know whether there was dyslexia in their family or not.

The mean summative score for those who had received special education in school was 165.79 (SD 34.6) as compared to 202.45 (SD 32.3) for those who had no history of special education, $t(131) = 4.53$, $p < 0.001$. These results show that both familial dyslexia and a history of special education are related to lower FS-DUVAN summative scores.

Sensitivity and specificity of the FS-DUVAN test for dyslexia diagnosis

Given the fact that language background was shown to have a significant effect on FS-DUVAN performance, we explored the feasibility of different cut-off points separately for the Swedish language background groups and the bilingual Swedish-Finnish language background groups. For this purpose we created receiver operating characteristic (ROC) curves using the summative score of the normal sample with Swedish language background ($n = 57$) and the SB suspected dyslexia sample ($n = 13$), as well as the summative score of the normal sample with Swedish-Finnish bilingual language background ($n = 21$) and the BB suspected dyslexia sample ($n = 9$) (see Figs. 1 and 2). The ROC curve enables the exploration of the trade-off between sensitivity (diagnosed true positives, here the individuals with suspected dyslexia) and specificity (diagnosed true negatives, i.e., the normal participants) of the FS-DUVAN summative score with different cut-off points (for the ROC curves, see e.g., Fan, Upadhye & Worster, 2006).

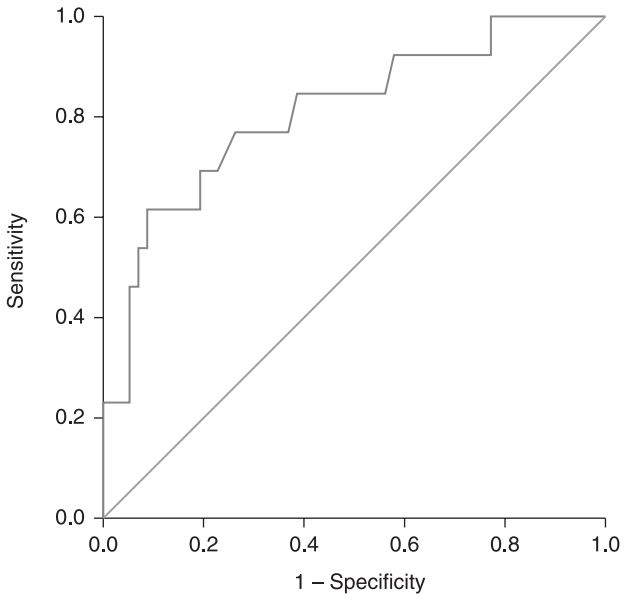

Fig. 1. ROC Curve for the FS-DUVAN summative score: normal performers (n = 57) and suspected dyslexia sample (n = 13) with Swedish language background.

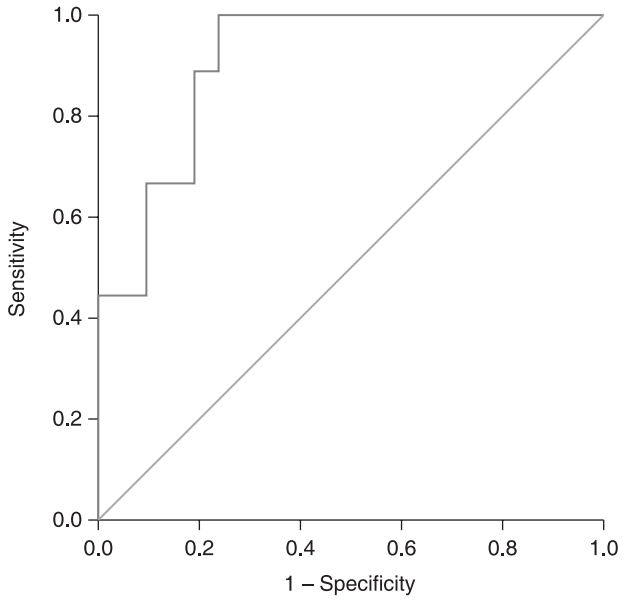

Fig. 2. ROC Curve for the FS-DUVAN summative score: normal performers (n = 21) and suspected dyslexia sample (n = 9) with Swedish-Finnish bilingual language background.

The summative score showed a sensitivity to 1-specificity profile with an area under the curve of 0.81 (p = 0.001) for the SB data and of 0.91 (p = 0.000) for the BB data. On the basis of the sensitivity and specificity analyses, we found an FS-DUVAN summative test score of 181.5 to be the optimal cut-off score for differentiating the SB suspected dyslexia students from the SB normals, and of 177.5 for differentiating the BB suspected dyslexia students from the BB normals. With this cut-off, 61.5% of the SB students with dyslexia diagnosis or those whom a teacher or a psychologist had categorized as dyslexics were correctly classified (n = 8), and the corresponding figure was 100% for the bilinguals (n = 9). These cut-off values resulted in a sensitivity of 0.615 for the SB and 1.0 for the BB, and a 1-specificity of 0.088 and 0.238, respectively.

DISCUSSION

In the present study, we adapted the Sweden-Swedish dyslexia group screening test DUVAN™ (Lundberg & Wolff, 2003; Wolff & Lundberg, 2003) into Finland-Swedish and collected normative data for Finland-Swedish university students in order to meet diagnostic needs at this educational level. Initial piloting with Finland-Swedes and analyses of the test items revealed cross-linguistic differences between Finland-Swedish and Sweden-Swedish, as well as more general cultural and linguistic concerns in the test material that prompted an adaptation of the DUVAN™ prior to collecting the Finland-Swedish data. Following the adaptation, new pilot tests were run with the FS-DUVAN, and finally randomly selected normative data from university freshmen was collected. Additionally, also a small group of students with previous dyslexia diagnosis participated in the study.

The variation in the language background of the subjects motivated an examination of language background effects on FS-DUVAN performance. We obtained the following significant group differences: normal subjects with Swedish language background scored highest on almost all of the subtests and on the summative score, followed by those with a bilingual Swedish-Finnish language background. The lowest scores were obtained by those with a Finnish language background. Although the DUVAN test is focusing on phonological skills (Lundberg & Wolff, 2003) and not on Swedish language proficiency per se, the tasks do require a specific level of Swedish language skills for maximum performance. Only in one subtest, Reversed Spoonerism, no statistically significant differences were observed between the language groups, and this is the subtest that can be considered least dependent on Swedish-language skills.

It should hardly be surprising that participants of different L1 backgrounds perform differently on a test that draws on language skills. Even if the participants in the present data with bilingual language background and those with Finnish as their stronger language all show a high level of proficiency in the Swedish language, we acknowledge the fact that, for instance, limited Swedish vocabulary and less contact with oral and written Swedish language, as well as the rigid time frames in the testing situation may influence the results in most FS-DUVAN subtests. Below we first shortly discuss these issues per each subtest of the FS-DUVAN and then turn to comparing performances of normals and dyslexics.

The target words in the Vocabulary task (C) consist of low frequency words (Wolff & Lundberg, 2003), which are likely to be less well mastered by the FB and the BB individuals than the SB individuals (cf. Ringbom, 1998). This was seen in our analysis as the FB participants reported a higher rate of guessing (47%) than the BB (40%) and the SB (28%) participants. Moreover, the FB group left 16% of the items empty or unanswered, while the corresponding rate was only 4% for the bilinguals and 2% for the SB individuals. In the Orthographic Choice task (F) targeting orthographic knowledge, the SB participants made the wrong choice in 3% of their answers and the BB participants in 5%. The FB individuals had a slightly higher percentage (7%) which also points towards limited Swedish orthographic skills within the FB group. The Phonological Choice task (E) draws heavily on the sound of words and one explanation for the poorer performance of the FB participants is that they have less experience also with spoken language. Furthermore, even though they have encountered Swedish grapheme-phoneme conversion rules in school, it is possible that their knowledge of these rules is not complete. Whereas only 3% of the marked words were incorrect in the SB and the BB groups, the percentage in the FB group was 16. In the speeded Working Memory task (B), one can expect that those less proficient in Swedish would need more time to process the Swedish sentences than those more proficient, leading to a lower performance for the FB group on this task (cf. Service, Simola, Mäntänheimo, & Maury, 2002). This may be reflected in the lower results of the FB. Interestingly, the Reversed Spoonerism task (D) showed no group differences. This task may be less reliant on specifically Swedish-language skills such as extensive vocabulary knowledge. Moreover, it does not include sentences or longer semantic chains. Nor does it heavily tax working memory.

These results stress the need to take the individual language background into account when interpreting the FS-DUVAN results. The findings that even early bilingualism seems to have an effect on the performance in tasks like those in the FS-DUVAN may be relevant when choosing tasks for other tests as well, as most individuals today have come into contact with more than one language from early on. Miller Guron and Lundberg (2003) point out that a prerequisite for successful assessment of phonological awareness in multilingual students is "sufficient exposure to the majority language". We can concur with this, and it is not just "exposure", but language proficiency in the specific language that is crucial.

Another issue may also be relevant when trying to explain some of the performance differences seen between the SB individuals and the FB individuals, namely that of transparency. For instance, Everatt *et al.* (2004) state that "certain [language] backgrounds may lead to different processing strategies" (cf. also Lehtonen & Laine, 2003; Portin & Laine, 2001) and refer, for instance, to transparency differences between orthographies (cf. e.g., Goulandris, 2003; Raman & Weekes, 2005; Reid & Fawcett, 2004; Seymour, Aro, & Erskine 2003; Smythe, Everatt, & Salter, 2004; Ziegler & Goswami, 2005; Ziegler *et al.*, 2003). Swedish orthography is fairly opaque, the Finnish one transparent (e.g., Seymour *et al.*, 2003).

To turn to the normals versus the suspected dyslexics, a comparison of the FS-DUVAN summative score between normal participants and suspected dyslexics with a Swedish language background (SB) and a bilingual Swedish-Finnish language background (BB), respectively, revealed statistically significant group differences. At the subtest level, the statistically significant group differences were somewhat variable, with the Orthographic Choice task (F) having the most consistent results, followed by the Working Memory task (B) and the Reversed Spoonerism task (D). Lundberg and Wolff (2003) report statistically significant group differences between dyslexics and controls on all subtests in their data, but maintain that the summative score is the critical one for deciding whether the performance of an individual should be considered as normal or not.

There may be several reasons for the variability of the FS-DUVAN subtest results when comparing the Finland-Swedish normal groups with the suspected dyslexia groups. For one, the sample sizes may influence the results, but also the fact that our suspected dyslexic individuals were all university students who probably have highly developed compensatory strategies. This we saw, for instance, in a conscious use of memory strategies in the Working Memory task, where both suspected dyslexic and normal participants reported having associated letters to be remembered with proper names of friends and family or linked them to identical letters that had already appeared in the task. Additionally, university students are likely to suffer from milder dyslexic deficits, which may challenge the sensitivity of the relatively short subtests.

In our selection criteria for dyslexics, we did not include a positive self-report on dyslexia in the family and a history of special education in school (e.g., Hagin, 2003). Instead we investigated this separately in relation to the performance on the FS-DUVAN. The results revealed that dyslexia in the family and a background of special education is associated with a poorer performance on the FS-DUVAN. This is in line with previous studies finding a higher frequency of dyslexics in families with dyslexia than without dyslexia, and that dyslexic difficulties persist into adulthood (e.g., Høien & Lundberg, 2000; Lyytinen *et al.*, 2004; Shaywitz *et al.*, 1999; Snowling, 2000; Snowling *et al.*, 2003; Stein, 2004; Svensson, 2003; Taipale *et al.*, 2003).

The criterion applied when including a participant in the suspected dyslexia group, i.e., a self-report of previous dyslexia diagnosis by a teacher or a psychologist (on the use of the self-report as a diagnostic tool, see e.g., Schulte-Körne, Deimel & Remschmidt, 1997; Wolff & Lundberg, 2003) will influence the results. There may be individuals in our normal data whose performance is affected by dyslexia but who

were not assigned to the suspected dyslexia group, and also such that were classified by a teacher as dyslexics but would not necessarily be so in a formal dyslexia test. An important validation for the FS-DUVAN as a diagnostic tool will be provided by an ongoing study where we compare matched groups of suspected dyslexics and normal university students on an extensive test battery, including a number of reading and writing tests.

With regard to the clinical use of the FS-DUVAN with Finland-Swedish university students, we searched for an optimal summative cut-off score in our data separately for students with Swedish language background and for those with Swedish-Finnish bilingual language background. The data we based this on is limited in size partly due to the strict selection criteria we used when grouping the participants according to early language background and partly because of the dyslexia criterion we employed. For the SB participants in our data, a cut-off score of 181.5 points succeeded in correctly classifying 61.5% of the suspected dyslexia participants (n = 8). It failed in correctly classifying five participants (8.8%) as normal performers as they scored below 181.5 points. A closer look at these low performers revealed one subject who reported dyslexia in the family and another one who was certain or fairly certain that she suffered from dyslexia, which are factors that may indicate dyslexia. These two individuals did not, however, fulfill our selection criteria to be included in the suspected dyslexia research group. Nevertheless, the true value of the calculated sensitivity of 0.615 may be slightly higher.

In line with our discussion above, there are several factors that apparently play a role in explaining why not all SB participants with a previous dyslexia diagnosis were identified. To mention but two here: the target group consisted of high-performing individuals (university students) able to compensate for mild developmental dyslexic deficits and not all individuals included in the suspected dyslexia group may in fact have been dyslexics. Altogether, the suitability of the cut-off score should be tested against larger data but these measures should provide a rough estimate of normal performance of Finland-Swedish university students with Swedish language background on the FS-DUVAN.

Regarding the participants with Swedish-Finnish bilingual language background, a lower cut-off score than the one for the SB group proved to be the most optimal one, which was to be expected as the bilinguals generally performed poorer on the FS-DUVAN than the SB participants. In our small sample, 100% of the BB suspected dyslexics (n = 9) were correctly identified with a cut-off of 177.5 points, whereas this score failed in correctly classifying five participants (23.8%) as normal performers. Two of these, however, reported that they were certain or fairly certain that they were dyslexics but had no previous documentation, one participant reported a history of special education in school, and one participant reported dyslexia in the family. In this respect, the specificity value may be slightly higher in the present data than the calculated one, but also for this group more data is needed to examine the cut-off. Additionally, limited Swedish language skills may influence the results in this group.

All in all, the areas under the ROC Curve and the sensitivity and specificity measures for the SB and the BB groups indicate a high potential for using the FS-DUVAN as a screening test for dyslexia among Finland-Swedes. For a dyslexia-*screening*, which is the main function of this test, it may be more appropriate to aim for higher sensitivity and lower specificity scores than a balanced measure, as those presented here, in order to optimize the inclusion of suspected dyslexics.

Our analyses have shown that the FS-DUVAN screening test distinguishes significantly between normals and suspected dyslexics with Swedish language background and those with bilingual language background on the summative score. Moreover, it distinguishes the Swedish groups on all the four areas measured in the screening test: phonological working memory, phonological representation, phonological awareness and orthographic skill, as well as on the dyslexia part of the self-report (cf. Lundberg & Wolff, 2003; Wolff & Lundberg, 2003) and the bilingual groups on all but phonological representation. However, these results do not include all subtests. Group comparisons failed to reach statistical significance for the Vocabulary (C), Phonological Choice (E), and Reversed Spoonerisms (D) subtests for the individuals with Swedish language background, and for the Vocabulary (C), Phonological Choice (E), and Working Memory (B) subtests for the individuals with bilingual language background.

To conclude, the FS-DUVAN, which we adopted for use among Finland-Swedes, should be a valuable dyslexia screening tool in higher education and also in other groups of adolescents in secondary education and vocational education, including high school students. Our data has indicated associations between tasks performances and language proficiency, which brings forward the need to take the language background of the participants into account when interpreting FS-DUVAN results of multilingual participants. We would therefore suggest that specific, detailed questions on the language background, even for highly proficient bilinguals, be included in the testing and taken into account when interpreting the results of tests for dyslexia.

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NOTES

[1] The piloting and adaptation of the FS-DUVAN took place during 2003 and was made by the first author in consultation with the second author.

[2] The points for the self-report are divided into those related to questions tapping one's reading interest and those tapping dyslexia. The points in the Internet-question affect the score on the reading interest measure, but not the so-called pure dyslexia score that goes into the summative score of the test.

[3] Originally 350 students were randomly selected, but nine of them were not actively studying and present at university even if categorized as such in the database (e.g., due to fulfilling their military service). The actual number of those receiving a letter of invitation to participate was therefore 341. Of these, 57 students had previously been studying at university but were registered as freshmen, e.g. due to change of their major subject.

[4] Gender and L1 distributions of Åbo Akademi University students (n = 7.950) enrolled in 2003 are as follows: 61% females; 76% L1 Swedish, 18% L1 Finnish (Swedish-Finnish bilinguals are included in these percentages, distribution unknown), 6% other L1. http://www.abo.fi/aa/kort_om_aa/kort_om_aa_2004_4.pdf Unchanged, 2 August 2005.

[5] The Matriculation Examination is taken at the end of upper secondary school and "the purpose of the examination is to discover whether pupils have assimilated the knowledge and skills required by the curriculum for the upper secondary school and whether they have reached an adequate level of maturity in line with the goals of the upper secondary school. Passing the Matriculation Examination entitles the candidate to continue his or her studies at university." Ylioppilaslautakunta. http://www.ylioppilastutkinto.fi/english.html, 9 June 2005.

[6] The number of participants who have taken the language entrance examination does not amount to the number of Finnish speakers in the sample. Applicants can be exempted from the test, which is likely to explain the figures here.

[7] The data from school records and the Matriculation Examination was retrieved from the electronic database at the university and complemented by archive searches by the first author with permission of the university administration.

[8] Exact Sig. [2*(1-tailed Sig.)], not corrected for ties.

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