ORIGINAL INVESTIGATION

Memory performance in dyslexic male juvenile delinquents convicted of severe offences does not differ from that in dyslexic male junior college students

HEIDI SELENIUS1, ANNA MARIA DÅDERMAN1,2 & ÅKE HELLOSTRÖM1

1Department of Psychology, Division of Biological Psychology, Stockholm University, Sweden, and 2Department of NEUROTEC, Division of Forensic Psychiatry, Karolinska Institute, Sweden

Abstract
Background: There are different research approaches regarding the causes and possible overrepresentation of dyslexia in criminals. One approach focuses on sociological explanations such as under-stimulation at home, while another focuses on the importance of cognitive neurobiological dysfunctions. In several studies, poor memory for digits and poor verbal learning ability have been found in non-criminal dyslexics.

Aim: To compare memory performance in two groups of dyslexics, namely, juvenile delinquents and junior college students, in order to discuss their dyslexic problems in the light of sociocultural and cognitive neurobiological approaches.

Participants: Two groups of male adolescent dyslexics: 11 juvenile delinquents (mean age 18.55 years, SD = 2.07), all of them convicted for severe offences, and 11 junior college students (mean age 17.09 years, SD = 0.83).

Results: Matched-samples t-tests indicate that there is no difference in memory performance between the two different groups of dyslexics, which supports the accuracy of the diagnoses of dyslexia in the group of juvenile delinquents.

Conclusions: The present results show that the memory performance of dyslexic juvenile delinquents does not differ from that of dyslexic junior college students. A sociocultural approach, therefore, cannot plausibly explain the high prevalence of reading and writing difficulties among juvenile delinquents.

Key words: Juvenile delinquents, junior college students, dyslexia, memory performance

Introduction
Reading or writing disorder (dyslexia) is persistent (Shaywitz et al. 1999) and exists in different populations with greatly different socioeconomic backgrounds (Duncan and Seymour 2000). According to DSM-IV (American Psychiatric Association 1994), dyslexia may be diagnosed in people with at least normal intelligence.

Short-term memory is related to reading and writing ability (Berninger et al. 2001). Dyslexics are characterised by having a poorer short-term memory than nondyslexics (Apthorp 1995; Lewis et al. 1980; Service and Tuulini et al. 2002; Siegal 1994) and, as a consequence, they have difficulties with decoding and spelling. A correct orthographic word decoding requires, according to Berninger et al. (2001), a good ability to encode written words into short-term memory and to have a good representation of these words in long-term memory. The phonological coding demands an ability to encode the spoken word into short-term memory, to structure and organise phonemes, and to reproduce the word without any kind of conscious support; this kind of strategy is labelled ‘phonological awareness’. It is common that dyslexics have an impaired phonological awareness (Elbro et al. 1994; Høien and Lundberg 1999).

Brosnan et al. (2002) reported that especially when distracted, dyslexics have a poorer memory for digits (WAIS-R; Wechsler 1981) compared with nondyslexics. On the other hand, Brosnan et al. stated that the spatial memory span, measured with the Cambridge Neuropsychological Test Automated Battery (CANTAB; CeNeS Cambridge Cognition 2005), is no poorer in dyslexics compared with nondyslexics. Adults with dyslexia might manage to compensate for their reading and writing difficulties rather well by using other cognitive strategies and...
abilities (such as a good performance in visuospatial memory), but they still have a lasting reduction in their memory for digits. Further, it is typical for dyslexics to have a poor verbal memory (Ackerman et al. 1990; Brosnan et al. 2003; Chiappe et al. 2000).

Interestingly, despite their poor verbal and short-term memory, dyslexics seem to have the skills required to perform well in visuospatial memory tasks and, for example, Brosnan et al. (2002) reported that dyslexics perform better than nondyslexics in visuospatial tests. According to von Karolyi et al. (2003), dyslexics have a special kind of visuospatial intelligence, and prefer to handle visuospatial information globally rather than sequentially. This kind of intelligence has been reported to influence the performance of dyslexics in the Rey Complex Figure Test (Lezak 1995). For example, in a study by Klicpera (1983) using this test, dyslexic children had forgotten more details, had drawn several details that did not exist in the test, and made several mistakes in the inner parts of the test.

The language centre being located in the left cerebral hemisphere, this hemisphere is dominant regarding language functions. When a person has to solve problems or respond to information, the dominant hemisphere becomes more electrically active. Research has shown that dyslexics have more symmetrical brains than nondyslexics (Shaywitz et al. 2000). In addition to the above-mentioned structural differences, dyslexics have abnormal brain functions (Shaywitz et al. 2000). The nootropic drug piracetam has been shown to improve dyslexics' reading and writing skills. In studies of dyslexic children, both reading comprehension and accuracy increased when they took piracetam (Deberdt 1994; Wilsher et al. 1987). Further, piracetam has been reported to improve memory and verbal learning in dyslexic children, as well as their speed of reading, writing, and spelling (Tallal et al. 1986; Wilsher 1986). Thus, there is good reason to study memory performance in different dyslexic populations, such as criminals, in order to find different ways to improve their memory as well as reading and spelling skills.

Several studies have found that there is an overrepresentation of dyslexia in criminals (40–70% compared to 4–8% in the normal population; e.g., Dalteg et al. 1999; Jensen et al. 1999; Kirk and Reid 2001; Dåderman et al. 2004; Selenius et al. 2004). These results have been criticized by researchers such as Samuelsson et al. (2000) and Svensson et al. (2003), whose opinion is that criminals are no more frequently dyslexic than others. Instead, Svensson et al. were of the opinion that the criminals' reading and writing difficulties are often caused by poor education, under-stimulation, and poor self-esteem, and Samuelsson et al. pointed to poor reading habits and concentration problems.

Previous studies verified differences in memory performance, that is, memory for digits as well as words and visuospatial material, between dyslexics and non-dyslexics, among inmates (Jensen et al. 1999) as well as male offenders referred for forensic psychiatric investigation (Dåderman et al. 1999; Dåderman et al. 2005). Jensen et al. (1999) reported that inmates with dyslexia performed more poorly than non-dyslexic inmates in digit span, both backwards and forwards, as assessed by the computerized Automated Psychological Test (APT) battery (Levander 1987a,b). Differences between inmates with and without dyslexia in the Claeson-Dahl verbal auditory learning and memory test (Claeson et al. 1971) have also been reported (Jensen et al. 1999). Dåderman et al. (2005) studied neuropsychological functions in a group of male offenders undergoing their forensic psychiatric investigation; those with dyslexia had poorer performance in a digit span test than those without. In the study by Dåderman and Lidberg, the offenders with dyslexia showed poorer performance in the Claeson-Dahl test than those without.

In the study by Dåderman et al. (1999), there were no significant score differences in the copy and memory tasks of the Rey Complex Figure Test between offenders with and without dyslexia. In contrast, Jensen et al. (1999) stated that inmates with dyslexia have poorer values in the copy task, but not in the memory task, compared with inmates without dyslexia. It is possible that this difference can be explained by a difference in nonverbal intelligence: in the study of Jensen et al., the inmates with dyslexia seemed to have lower mean scores in the nonverbal intelligence tests SRB-2 and SRB-3 (Dureman and Sälde 1959) than the offenders in the study of Dåderman et al. In a group of male inmates, Cornell et al. (1997) reported a positive association between the scores in the copy and memory task of the Rey Complex Figure Test and those in SRB-3.

In summary, research consistently shows over-representation of reading and spelling difficulties in the criminal population. These difficulties are associated with impaired memory performance, which indicates that they are due to dyslexia. Nevertheless, several influential researchers still state that reading and spelling difficulties in criminals depend on under-stimulation and other sociocultural causes, and not on biological or neuropsychological causes, such as dyslexia or poor memory.
Study aim

Our aim was to compare memory performances in two groups of males diagnosed as dyslexics, namely, juvenile delinquents and junior college students, in order to discuss their reading and spelling difficulties in light of the sociocultural and cognitive neurobiological approaches. According to previous findings (Ackerman et al. 1990; Brosnan et al. 2002; Chiappe et al. 2000; Dåderman et al. 2005), we did not expect to find any differences in memory performance between juvenile delinquents and junior college students. An absence of differences in memory performance between the groups would confirm the dyslexic nature of the juvenile delinquents' reading and spelling problems. Their poor performance in written language may then not be just as a result of sociocultural factors, as has been claimed (Samuelsson et al. 2000; Svensson et al. 2003). This may open a possibility for medical and cognitive treatment of their poor memory in order to improve their writing and spelling performance.

Materials and methods

Participants

Nineteen non-psychotic male juvenile delinquents convicted of severe offences participated voluntarily in two projects relating to dyslexia (see Dåderman (2000, 2002) for descriptions of these dyslexia projects; and Dåderman et al. (1999), Selenius (2003) and Selenius et al. (2004) for results regarding dyslexia and memory performance), which were performed in two different settings: in an institution for long-term medical and psychological assessment and in a forensic psychiatric department.

Juvenile delinquents in an institution for long-term medical and psychological assessment. From December 1997 to February 1999 all (14) male juvenile delinquents in a Swedish state institution for long-term medical and psychological assessment (Åby department at Lovsta boarding school, at Huddinge near Stockholm), who fulfilled inclusion criteria and were allowed to participate, were asked to participate in a project regarding dyslexia. The present study is a part of the project. These juvenile delinquents had been in the institution for approximately 6 months before being admitted to different youth correctional institutions. Four were, for different reasons, not allowed to participate. One juvenile delinquent refused to participate for the reason that he considered himself as not having dyslexia; he stated that he had previously performed dyslexia tests in another correctional institution and that these tests showed that he did not suffer from dyslexia. Thus nine delinquents from the institution participated in the study. They had previously been reported not to differentiate from other juvenile delinquents in correctional institutions (cf. Dåderman 2002) regarding relevant characteristics, such as age, education, ethnicity, personality, and family situation, as well as offending, alcohol and drug abuse/dependence.

Juvenile delinquents in a forensic psychiatric investigation. From November 1997 to November 1998, all nonpsychotic male offenders who did not need a translator were asked to participate in another project regarding dyslexia. Among these, 12 were juvenile delinquents who had committed a crime before the age of 22, and 10 of them agreed to participate. All of them had been referred to a forensic psychiatric investigation at the Department of Forensic Psychiatry in Stockholm (Huddinge unit) before being sentenced. Thus, 19 of 26 juvenile delinquents participated in the present study.

Eleven of the 19 participants (58%) fulfilled the DSM-IV criteria for dyslexia. For the aims of the present study, these juvenile delinquents with dyslexia had been matched pairwise with a group of junior college students with dyslexia (see Procedure for the details regarding matching criteria); thus, the participants in the present study consisted of 11 juvenile delinquents with dyslexia and 11 junior college students with dyslexia; all fulfilled diagnostic criteria for dyslexia (both reading and writing disability) according to DSM-IV.

For a description of demographic data see Table I.

Ethics

All of the juvenile delinquents and junior college students participated voluntarily. They received both oral and written information about the aims of the study, and had given written permission that their results could be used in research. Before participation, the parents of those junior college students who were younger than 18 years had also given their written permission, allowing their child to participate. The junior college students were informed about the possibility that the results would be used as control data in a study regarding juvenile delinquents. Both oral and written information was given according to the recommendation of the ethics committee at the Karolinska University Hospital, which approved both dyslexia projects.
Table 1. Demographic data and results of intelligence tests for the two groups with dyslexia.

<table>
<thead>
<tr>
<th></th>
<th>Juvenile delinquents (n = 11)</th>
<th>Junior college students (n = 11)</th>
<th>df</th>
<th>t</th>
<th>( \phi^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD) min–max</td>
<td>M (SD) min–max</td>
<td>----</td>
<td>------</td>
<td>-------------</td>
</tr>
<tr>
<td>Age (years)(^3)</td>
<td>18.55 (2.07) 16–22</td>
<td>17.09 (0.83) 16–18</td>
<td>13</td>
<td>2.17</td>
<td>0.05</td>
</tr>
<tr>
<td>Education (years)(^3)</td>
<td>8.94 (1.63) 7.0–12.3</td>
<td>9.86 (0.32) 9.5–10.5</td>
<td>11</td>
<td>-1.85</td>
<td>0.09</td>
</tr>
<tr>
<td>Intelligence tests(^1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocabulary</td>
<td>4.09 (1.45) 1–8</td>
<td>4.36 (2.58) 2–8</td>
<td>20</td>
<td>-0.27</td>
<td>0.79</td>
</tr>
<tr>
<td>SRB-2, Figure Classification</td>
<td>5.82 (2.18) 2–9</td>
<td>5.64 (1.36) 4–8</td>
<td>20</td>
<td>0.23</td>
<td>0.82</td>
</tr>
<tr>
<td>SRB-3, Block design</td>
<td>7.18 (1.88) 3–9</td>
<td>7.27 (1.85) 3–9</td>
<td>20</td>
<td>-0.11</td>
<td>0.91</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immigrant background(^4)</td>
<td>8 (72.7)</td>
<td>5 (45.5)</td>
<td>1</td>
<td>1.69</td>
<td>0.19</td>
</tr>
<tr>
<td>Disharmonious family(^5)</td>
<td>4 (36.4)</td>
<td>5 (45.5)</td>
<td>1</td>
<td>0.19</td>
<td>0.67</td>
</tr>
</tbody>
</table>

\(^1\)The Stanine values for the intelligence tests were calculated individually according to the number of years of education.

\(^2\)On categorical data (immigrant background and disharmonious family), \( \chi^2 \) was calculated.

\(^3\)Tests were used on continuous data.

\(^4\)Levene's test indicated nonequality of variance and therefore a special formula for the t-tests was used.

\(^5\)Participants who were born abroad, or one or both biological parents of whom were born in another country, were seen as having an immigrant background.

A participant who did not grow up with both biological parents was classified as having a disharmonious family.

Memory tests

To measure verbal auditory learning and memory, the Swedish test of verbal list learning, Claeson–Dahl (Claeson et al. 1971) was used. The test consists of 10 non-related bisyllabic words, which are read aloud and may be repeated up to 10 times. There is free recall immediately after each reading, after an interval of 15 seconds, and also after 30 minutes. The free delayed recall task after 30 minutes was excluded from the present study, because previous research (e.g., Jensen et al. 1999) has shown no significant differences between dyslexics and non-dyslexics in this respect.

In order to measure visuoconstructive memory, the Rey–Osterrieth Complex Figure Test was used (Rey 1941). Both copying and delayed recall was performed; the delayed recall was administered 3 minutes after the copying procedure. The scoring was done according to Taylor (1959), as described in Lezak (1995, p 572).

The digit span was measured by the computerised Automated Psychological Test (APT) test battery (Levander 1987a,b). The Digit span test in APT is a process-controlled version of the WAIS-type digit span test. For further description of the test see, for example, Levander (1987a,b). Performance in the test is calculated as the median of the number of correctly recalled digits of the three last series in both the forward and backward tasks.

Procedure

The procedure of acquiring data from juvenile delinquents has been described elsewhere. In brief, one of us (AMD) examined the juvenile delinquents (see Dåderman 2000, 2002), while another of us (HS) examined the junior college students. Some male students were recognised as having dyslexic difficulties by two special pedagogues, who had previously performed screening tests for reading and writing difficulties among all junior college students in two different schools. Twelve junior college students were asked by these special pedagogues to participate in the present study, and all of them agreed to do so. The participants were told that they would get a dyslexia certificate if they fulfilled the criteria for dyslexia according to DSM-IV. The examinations among the juvenile delinquents and the junior college students were carried out using similar procedures. The participants were examined individually in a room with no disturbing noises, and they had the possibility to take breaks during the interviews and tests.

The assessments of dyslexia were made individually, taking into account the total amount of years each participant had attended school. In accordance with DSM-IV, dyslexia was diagnosed if, in at least three reading and spelling tests out of four, a participant achieved a score more than one SD unit below his highest score in two nonverbal intelligence tests (i.e., SRB-2, SRB-3; Dureman and Sälde 1959). In other words, a discrepancy criterion was used. The same assessment procedure was used in several Swedish studies (e.g., Jensen et al. 1999; Selenius et al. 2004).

The male juvenile delinquents with dyslexia were then matched for nonverbal intelligence with the male junior college students with dyslexia. This
Matching was done in consideration of the DSM-IV discrepancy criterion for dyslexia, but also because, in a previous study on criminals (Cornell et al. 1997), the employed memory tests had previously shown a positive correlation with nonverbal intelligence as measured by Rey Complex Figure Test and SRB-3. The juvenile delinquents were matched in pairs with the junior college students according to the following procedure, designed by the present authors: first the raw scores from SRB-2 and SRB-3 were summed. In the data file, the delinquents and students were paired according to the within-group rank of the score sum. The juvenile delinquent with the highest sum was paired with the junior college student with the highest sum, etc.

Treatment of data and statistical analyses

In this study, normative values (T-scores or Stanine values) were used in all statistical analyses. These analyses were performed with SPSS, version 11.0 for MacOS X (SPSS 2001). In order to predict the group membership from a set of predictors, a discriminant function analysis (DFA) based on T-scores from the three tests, Claeson–Dahl, Rey Complex Figure, and APT Digit span, was performed to find classification functions (Tabachnick and Fidell 2001).

Results

Memory performance

The mean value differences in the test scores in the juvenile delinquents with dyslexia and in the junior college students with dyslexia were tested with matched-samples t-tests (Graziano and Raulin 2000; Lawrence et al. 2002). The results (see Table II) indicate no significant differences, tests for linearity, normality, and homogeneity of variance–covariance matrices revealed no threat to multivariate analysis. No significant function was found in the discriminant analysis (Wilks' $\lambda = 0.81; \chi^2 = 3.02; P = 0.39$). A stepwise analysis was not possible to perform, because no variables qualified for such an analysis.

Correlations between test scores from the memory tests and nonverbal intelligence tests

Table III shows the correlation matrix concerning mean scores in memory and nonverbal intelligence tests in the total sample.

Power analyses

Power analyses for matched-samples t-tests (Cohen 1969; Howell 2002) were performed by using

Table III. Correlations between scores in memory and nonverbal intelligence tests ($N = 22$).

<table>
<thead>
<tr>
<th>Test</th>
<th>Rey&lt;sub&gt;copy&lt;/sub&gt;</th>
<th>Rey&lt;sub&gt;memory&lt;/sub&gt;</th>
<th>Claeson–Dahl</th>
<th>Digit span</th>
<th>SRB-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rey Complex Figure Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copy (Rey&lt;sub&gt;copy&lt;/sub&gt;)</td>
<td>0.12</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Memory (Rey&lt;sub&gt;memory&lt;/sub&gt;)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Claeson–Dahl</td>
<td>0.39</td>
<td>0.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digit span, APT&lt;sup&gt;1&lt;/sup&gt;</td>
<td>0.15</td>
<td>0.32</td>
<td>0.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRB-2, Figure Classification</td>
<td>0.14</td>
<td>0.46*</td>
<td>-0.08</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>SRB-3, Block design</td>
<td>0.12</td>
<td>0.31</td>
<td>-0.24</td>
<td>0.48*</td>
<td>0.56**</td>
</tr>
</tbody>
</table>

*$P < 0.05$, **$P < 0.01$. Results of memory tests are based on T-scores and those of intelligence tests on Stanine values.

<sup>1</sup>Performance was calculated as the median of the number of correctly recalled digits of the three last series in each forward and backward task in the computerised test in the Automated Psychological Test (APT) battery (Levander 1987a, b).
Table IV. Power calculations for matched-samples t-test.

<table>
<thead>
<tr>
<th>Test</th>
<th>( d )</th>
<th>( \delta )</th>
<th>Power</th>
<th>( n )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rey Complex Figure Test</td>
<td>0.54</td>
<td>1.79</td>
<td>0.37</td>
<td>29</td>
</tr>
<tr>
<td>Memory</td>
<td>0.07</td>
<td>0.23</td>
<td>0.04</td>
<td>1604</td>
</tr>
<tr>
<td>Claeson–Dahl</td>
<td>0.83</td>
<td>2.75</td>
<td>0.70</td>
<td>14</td>
</tr>
<tr>
<td>Digit span, APT(^1)</td>
<td>1.09</td>
<td>3.45</td>
<td>0.90</td>
<td>9</td>
</tr>
</tbody>
</table>

\( d \) is the assumed effect size based on Jensen et al. (1999). \( \delta \) is the noncentrality parameter, an index of effect size and sample size. Power is the estimated probability of rejecting a false null hypothesis at a given significance (\( \alpha \)) level (in the present study, \( \alpha =0.05 \), two-tailed). \( n \) is the number of pairs of observations that is required for a power of 0.80.

\(^1\)Performance was calculated as the median of the number of correctly recalled digits of the three last series in each forward and backward task in the computerised test in the Automated Psychological Test (APT) battery (Leverder 1987a,b).

an online power calculator (UCLA 2005) to find out the probability of getting statistically significant results. The effect sizes were estimated according to results by Jensen et al. (1999). Power calculations, using these effect sizes, are shown in Table IV.

Discussion

Different opinions about the over-representation of dyslexia in criminal samples have caused debate (e.g., Lundberg 2000) about the origins of reading and spelling difficulties and the possible overrepresentation of dyslexia in criminals. Therefore, the aim of the present study was to compare memory performance in two groups of dyslexics in order to discuss their dyslexic problems in light of the sociological and cognitive-neurobiological approaches. As expected, the results showed no differences between the male juvenile delinquents and the junior college students in their memory performance. Thus, it seems that dyslexia in criminals is equally genuine as in noncriminal.

Clinical and theoretical implications

Dyslexics have been reported to have a poorer short-term memory (Ackerman et al. 1990; Brosnan et al. 2002; Chiappe et al. 2000) and a better visuospatial intelligence (von Karolyi et al. 2003) compared to nondyslexics. Their specific form of visuospatial intelligence (handling the information globally rather than sequentially) may be useful in memory tests that are focused on visuospatial memory. In the present study, we found no significant difference in memory performance in juvenile delinquents with dyslexia compared to junior college students with dyslexia. Therefore, the results seem to support the accuracy of the diagnoses of dyslexia in the juvenile delinquents. For many years, influential Swedish dyslexia researchers, such as Ingvar Lundberg and his co-workers (Samuelsson et al. 2000; Svensson et al. 2003), have maintained that dyslexia is over-diagnosed in criminal samples, and contended that the causes of reading and writing difficulties in criminals are found in their problematic and under-stimulating sociocultural backgrounds.

In the present study, data regarding dyslexia in juvenile delinquents were taken from recently reported studies (Döderman and Lidberg 2004; Selenius 2003), which took place in 1997–1998. In accordance with DSM-IV, a discrepancy criterion (for details see Procedure) was used in order to assess dyslexia in these studies. The same criteria were therefore used for sampling of data in the matched group of adolescents. All participants were diagnosed as dyslexics because they fulfilled the criterion for both reading and writing difficulties. The length of their education was taken into consideration in the individual assessments. Even though poor phonological awareness has been seen as typical for persons with dyslexia (Höfén and Lundberg 1999), this kind of phonological tests have not previously been included in the research design of the above-mentioned studies for the reason that, in DSM-IV, poor phonological awareness is not a condition that yields a diagnosis of dyslexia. However, it is known that youngsters and adults with dyslexia have spelling difficulties, decoding problems, and a low speed of reading (Olofsson 1999; Shaywitz et al. 1999). Such difficulties were also typical for the participants in the present study. Much of the debate about the dyslexia concept is often focused on what kind of difficulties have to be present for the diagnosis of dyslexia to be given. Some researchers (Gustafson and Samuelsson 1999; Höfén and Lundberg 1999) focus on poor phonological awareness, whereas other researchers and clinicians proceed from the criteria in DSM-IV (Jensen et al. 1999; Selenius et al. 2004).

In addition, some researchers (e.g., Stanovich 2000) subdivide the concept of dyslexia into phonological dyslexia and surface dyslexia. In both these subtypes of dyslexia, a discrepancy exists between reading and spelling ability and nonverbal intelligence. The difference between the two subtypes is that a person with phonological dyslexia, but not one with surface dyslexia, has evident difficulties concerning phonological awareness. We suggest that a future study should, in addition to the tests used by us, include phonological tests. Such a study might possibly answer the question whether juvenile
delinquents suffer from phonological dyslexia or surface dyslexia.

The correlation matrix (Table III) shows, as expected, a correlation close to zero between test scores in the Claeson–Dahl test and the Rey Complex Figure Test (r = 0.10). These two tests measure different types of memory. The Claeson–Dahl test is a test for verbal learning, which has been acknowledged to be problematic for dyslexic children (Messbauer and de Jong 2003). The power of the matched sample t-test was high for both Claeson–Dahl and Digit span (see Table IV). Therefore, the lack of significant differences in memory performance indicates that juvenile delinquents have genuine dyslexic problems, and thus that their spelling and reading difficulties are not just due to a poor school background and under-stimulation.

The estimated power was low for the Rey–Osterrieth Complex Figure Test: 37% in the copy task and 4% in the memory task (see Table IV), and consequently it is difficult to get significant results. Power would increase if a larger number of participants were included in the study. Some differences may be expected between juvenile delinquents and junior college students: the juvenile delinquents have been in violent acts and fights, which may result in brain injuries. Such injuries may be indicated by low performance in the Rey Complex Figure Test. Also, compared to the juvenile delinquents, the junior college students show less abuse of alcohol and drugs, and thus they might be expected to show a better performance in this test.

A possible problem with the present power analyses is that they are based on results from a criminal sample (cf. Jensen et al. 1999). Using results from a study on noncriminal persons with and without dyslexia might result in other effect sizes and therefore other power levels in the three memory tests. We could, however, not find any relevant published study.

In a previous study on male offenders undergoing a forensic psychiatric examination with and without dyslexia, differences in cognitive functions were found (Dåderman et al. 2005). It would therefore be valuable to investigate other cognitive functions besides memory to find out whether the juvenile delinquents with dyslexia are similar to junior college students with dyslexia. For example, Dalteg et al. (1997) have reported that dyslexics and criminals use the same type of strategies in processing information, but this finding has not been confirmed in the present sample because these data have not been processed.

As was mentioned in the Introduction, both brain structures and functions (e.g., a more symmetrical brain, abnormal functional deviations in Broca's area and Wernicke's area) have been shown to exist among dyslexics (Shaywiz et al. 2000). The drug piracetam has been reported to improve spelling and reading skills, as well as verbal memory among children and students with dyslexia (e.g., Deberdt 1994; Tallal et al. 1986; Wilsher 1986; Wilsher et al. 1987). Further research should investigate the possible therapeutic value of this drug.

In previous studies on noncriminal groups (e.g., von Karolyi et al. 2003) and a sample of male offenders referred to forensic psychiatric investigation (Dåderman et al. 2004), dyslexics have been reported to perform well in the Rey Complex Figure Test, which was also the case in the present study. Therefore, the good visuospatial memory of dyslexics might be important as a support for their learning in different situations.

The school backgrounds of the juvenile delinquents in this study have been problematic (e.g., learning and concentration difficulties, truancy; see, e.g., Dåderman 2002; Selenius 2003), and their dyslectic problems had not been noted in the forensic psychiatric assessment files or in the investigation files at the youth correctional institution. Only one of the juvenile delinquents, belonging to the group of offenders referred for forensic psychiatric investigation, had documented reading and writing difficulties in his institutional file. On the other hand, in the institutional files (cf. Dåderman 2002) there are notes concerning learning difficulties in school among the juvenile delinquents. These difficulties are well reflected in the present results for the verbal tests as compared to the nonverbal intelligence tests (Table I). The juvenile delinquents as well as the junior college students have the intellectual capacity to perform well in school, if their good abilities are used as starting points for learning and teaching. For example, it might have been an advantage for both the juvenile delinquents and the junior college students in this study if new things had been taught to them in such a way that they could take advantage of their visuospatial memory and logical-analytic intelligence.

Study limitations

There were few participants in this study, and therefore it is impossible to generalise the results to all male juvenile delinquents and male junior college students with dyslexia. Furthermore, the participants might not be very representative of their populations. For example, the selection of junior college students made by the two special pedagogues cannot be checked; there might be other students who scored low in the screening test but who were
not given the same attention. But, on the other hand, 11 of the 12 junior college students with poor screening results turned out to fulfill the dyslexia criteria, according to DSM-IV, and were therefore included in the present study.

In addition to the tests used in the present study, a future study should include an instrument to assess the possible presence of attentional deficit hyperactive disorder (ADHD, American Psychiatric Association 1994). Dyslexia has a high co-morbidity with ADHD (Pennington 1991). The assessment of ADHD in Sweden was not as attentive in 1998 as it is today. Therefore, it might be interesting to investigate the possible relationship between ADHD and self-reported crimes among junior college students, and whether the frequency of ADHD, like that of dyslexia, is higher in juvenile delinquents than in junior college students.

Conclusions

Memory performance in the male juvenile delinquents with dyslexia did not differ from that in the male junior college students with dyslexia. A socio-cultural approach, therefore, seems to fail to explain reading and writing difficulties among juvenile delinquents. The results support the diagnoses of dyslexia in the juvenile delinquents, and at the same time elucidate their difficulties with tasks based on short-term memory. Well-functioning reading and writing abilities are based on good memory performance. Both the juvenile delinquents and the junior college students showed good visuospatial memory, which it might be advantageous to use in educational situations. The power was poor in the test measuring visuospatial memory, and therefore the result should be interpreted carefully. A further study with larger groups of dyslexic juvenile delinquents and dyslexic junior college students would result in higher power. However, in Sweden it would be hard to recruit a large number of juvenile delinquents convicted of severe offences.

Dyslexic juvenile delinquents might give more extensive answers in legal questioning if they are offered the possibility to use their strong basic assets (e.g., to use their memory for pictures instead of naming places, names, phone numbers, etc.). More research concerning neuropsychological functions in juvenile delinquents with dyslexia should reveal information about their strengths and difficulties, which might be helpful in planning of treatment and for remedial strategies. There is also a need for further studies to find out why dyslexics are more likely than others to get into severe criminality and substance abuse.

Acknowledgements/Statement of Interest

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