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Motor Sequence Learning in Dyslexia: Is consolidation the key?

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ABSTRACT. There is uncertainty as to whether the deficits in developmental dyslexia extend beyond the language domain. In the present study, the time course of procedural learning of a motor sequence skill was followed over a 24 hour period. 13 dyslexic adults and 12 control adults matched for age and intelligence were asked to repeat a sequence of finger movements as many times as possible in 30s. They were then trained on the sequence for 400 slow, paced trials and then re-tested for maximum speed. A third testing session was carried out 24hrs after the initial tests (without any further practice). Performance of the two groups did not differ immediately after training, but the dyslexic group showed significant performance deficits initially and immediately after the 24hr break. The latter strongly suggests an impairment in consolidation of learning (a prerequisite for normal automatization), together with normal ability to learn during explicit practice. These findings applied strongly to some dyslexic participants whereas others performed normally, reflecting the considerable heterogeneity of this disorder. The findings provide a novel explanation of why dyslexic children have difficulty learning to read, and may have considerable applied and theoretical implications.

SUMMARY. There is uncertainty as to whether the deficits in developmental dyslexia extend beyond the language domain. In the present study, the time course of procedural learning of a motor sequence skill was followed over a 24 hour period. 13 dyslexic adults and 12 control adults matched for age and intelligence were asked to repeat a sequence of finger movements as many times as possible in 30s. They were then trained on the sequence for 400 slow, paced trials and then re-tested for maximum speed. A third testing session was carried out 24hrs after the initial tests (without any further practice). Performance of the two groups did not differ immediately after training, but the dyslexic group showed significant performance deficits initially and immediately after the 24hr break. The latter strongly suggests an impairment in consolidation of learning (a prerequisite for normal automatization), together with normal ability to learn during explicit practice. These findings applied strongly to some dyslexic participants whereas others performed normally, reflecting the considerable heterogeneity of this disorder. The findings provide a novel explanation of why dyslexic children have difficulty learning to read, and may have considerable applied and theoretical implications.

Keywords: Developmental Dyslexia, Motor Sequence Learning, High attention deficit
INTRODUCTION

Dyslexia is traditionally defined as a child’s failure “…to attain the language skills of reading, writing and spelling commensurate with their intellectual abilities” (World Federation of Neurology, 1968). Since reading is by no means an innate skill, it may seem evident that dyslexia should be associated with impaired function of some type or process of skill learning. However, major frameworks for dyslexia have argued convincingly that this is not a necessity. The magnocellular framework holds that impairments arise in sensory processing, either within the visual modality (Stein & Walsh, 1997) or the auditory modality (Tallal, Miller & Fitch, 1993), and that these sensory impairments lead to problems in the efficient processing of visual or auditory information that lead in turn to impaired central processing in these modalities. The phonological deficit theorists (Stanovich, 1988) hold that the core deficit lies in impaired representations or function within the phonological module, and is generally limited to language-based processing, with unimpaired central learning processes (Vellutino, Fletcher, Snowling & Scanlon, 2004). It is beyond the scope of this article to address these issues (see Demonet, Taylor & Chaix, 2004; Ramus, White & Frith, 2006 for recent analyses), but suffice it to say that it is important to explore possible explanatory frameworks in parallel rather than in opposition.

The first theoretical framework based explicitly on learning was in terms of automatisation, the process via which, through long practice, a skill becomes automatic, and therefore no longer demanding constant attentional supervision. The automatisation deficit hypothesis (Nicolson & Fawcett, 1990) proposed that dyslexia is associated with impaired automaticity, such that everyday skills require a greater degree of conscious supervision than normal, and consequently less resources are available for other tasks. While this characterisation is acknowledged to be appropriate for literacy-related skills, and is consistent with the phonological deficit framework, it caused controversy by suggesting that non-linguistic skills such as motor skill would also be affected. In subsequent research, Nicolson and Fawcett undertook a series of studies investigating the learning processes. One study (Nicolson & Fawcett, 2000) revealed marked impairment in the process of blending two simple reactions into a choice reaction. This study provided a theoretical underpinning for the established good practice of proceeding in small steps for dyslexia (Miles, 1989) and also highlighted difficulties in non-linguistic skill learning (the stimuli were a tone and a flash). A further study (Nicolson, Daum, Schugens, Fawcett & Schulz, 2002) demonstrated that there were subtle deficits in classical conditioning of the eyelid, but interestingly that the deficits applied more to the adaptation of the blink timing to occur just before the airpuff, rather than the conditioning itself. A prism adaptation study (Brookes, Nicolson & Fawcett, 2007) revealed that a group of dyslexic children (and a group of dyspraxic children) showed impaired rate of adaptation to the wearing of prismatic lenses. Both these studies provide direct support for the cerebellar deficit hypothesis for dyslexia (Nicolson, Fawcett & Dean, 1995, 2001) in that these primitive learning functions are considered to be specific to the cerebellum. A brain imaging study (Nicolson et al., 1999) led to the interesting finding that although dyslexic adults automatised the execution of a simple sequence of button presses, and performed within the normal bands, unlike the control group they were not using their cerebellum either in the learning or the execution process.

Further evidence consistent with the cerebellar deficit framework comes from implicit learning using the serial reaction time task, in which a participant makes responses to a supra-span sequence of stimuli. Implicit learning is shown by a specific increase in speed of responses within the sequence even though the participant is not consciously aware that there are any regularities. Several studies have now established that dyslexic children do not show this unconscious facilitation effect (Menghini, Hagberg, Callagirone, Petrosini & Vicari, 2006; Stoodley, Harrison & Stein, 2006).

The range of difficulties established led Nicolson & Fawcett (2007) to propose that dyslexia is associated with a deficit in procedural learning, whereas their declarative, explicit learning is intact (and perhaps overperforming, see also Nicolson & Fawcett, 2011). This hypothesis was influenced by the work of Ullman, who identified a procedural/declarative differentiation in language as well as motor systems (2001, 2004), and is consistent with the Functional co-ordination deficit model of Lachmann and Leeuwen (2014). The hypothesis has been well received, and evidence in support of the procedural learning deficit hypothesis has come from a range of studies. In a recent meta-analysis of Serial reaction time in dyslexia by Ullman and colleagues (Lum, Ullman & Conti-Ramsden, 2013) found impairments indicative of procedural learning deficits, with smaller effects in older participants. Studies from Gabay and
Decoding automaticity in reading process and practice

How much influence does summer vacation have on children’s reading abilities in primary school?

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ABSTRACT. La presente ricerca si prefigge di indagare quanto possa incidere l’esercizio nell’incremento dell’abilità di lettura a voce alta nei bambini in fase di apprendimento. Il metodo scelto per verificare l’importanza dell’esercizio è stato quello di misurare le conseguenze che scaturiscono dalla sostanziale riduzione di questo durante il periodo estivo. Il paradigma adottato prevede la somministrazione di tre diverse prove di lettura standardizzate (liste di parole, non parole e brano) a gruppi di bambini dalla classe 1ᵃ alla classe 5ᵃ elementare, in tre momenti dell’anno (fine anno scolastico, inizio anno scolastico e a distanza di 2 mesi da questo). Dati in letteratura mostrano che la sospensione dell’esercizio causata dalle vacanze estive produca effetti dannosi per la matematica e l’ortografia, mentre i risultati riguardanti l’abilità di lettura sembrano essere discordanti (Cooper, 1996; Allinder et al., 1992). I risultati della presente ricerca mostrano che i parametri di velocità e accuratezza risentono diversamente sia della diminuzione che dell’aumento dell’esercizio. Per tutte le classi esaminate si assiste ad un aumento costante della velocità e la sospensione dell’esercizio sembra non esercitare effetti significativi sulla prestazione. Tale incremento della velocità di lettura sembra accompagnarsi, nelle prime classi, ad un aumento della percentuale di errori in seguito al riposo estivo. Pertanto la comparazione dei diversi dati emersi porterrebbe ad ipotizzare l’esistenza di meccanismi indipendenti sottostanti allo sviluppo e all’automatizzazione dei due fattori analizzati.

SUMMARY. This research intends to investigate the impact of reading practice on children’s read-aloud abilities during the learning phase. In order to assess the importance of reading practice, the researchers have examined the possible adverse consequences arising from the substantial reduction in exercise during the summer vacation. According to the model adopted, groups of children from grade first to fifth in primary school have been given three different standardized tests (lists of words, pseudo-words and a text), in three distinct times of the year (end of school, beginning of school and two months after that). The available literature on the subject demonstrates that summer vacation can have a detrimental impact on maths computation and orthography whereas the results relating to reading abilities seem to be considerably disparate (Cooper, 1996; Allinder et al., 1992). The outcomes of this research prove that speed and accuracy parameters are affected differently by both the decrease and the increase in reading practice. All assessed classes have shown a regular increase in reading speed, and the suspension of the learning practice does not seem to have influenced the performance significantly. This improvement in reading speed apparently comes with an increase in the percentage of mistakes made after summer vacation, especially in the first classes. Therefore, the comparison of the provided results might suggest the existence of independent mechanisms lying behind the development and automaticity of the two examined factors.

Keywords: Reading practice, Standardized test, Summer vacation
The role of the Working Memory in the early phases of learning to read

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ABSTRACT. Il contributo presenta una ricerca condotta su un campione di bambini italiani e inglesi per studiare il ruolo svolto dalla memoria di lavoro sulle prime fasi dell’apprendimento della lettura. Inoltre viene confrontato lo sviluppo dei processi tipici della memoria di lavoro in popolazioni parlanti lingue a diversa consistenza ortografica (trasparente e opaca). Dalla ricerca emerge che, nelle fasi precedenti l’insegnamento sistematico e formale della letto-scrittura, nei bambini italiani sono le componenti visuo-spaziali a breve termine a interessare la capacità di decodifica; mentre nei bambini inglesi la via di decodifica fonologica è predetta dalla capacità della memoria a breve termine e quella di accesso diretto dalla capacità di memoria visuo-spaziale. Per quanto concerne, invece, le prime fasi della lettura e della decodifica, nei bambini italiani prevale il ricorso alla componente verbale; mentre i bambini inglesi ricorrono alle risorse visuospaziali per effettuare la decodifica fonologica e a quelle cognitive per quella lessicale. In conclusione, i bambini italiani utilizzano prevalentemente strategie di decodifica seriale, mentre quelli inglesi strategie di tipo logografico.

SUMMARY. Several studies have revealed that the working memory and its components are involved in the process of learning to read and Baddeley’s model (1986) best grasps this process as a whole. The first aim of this study is to carry out a longitudinal study on typical developed children, in order to assess the temporal evolution of the working memory process in relation to the transcoding process. The second purpose of this study is to compare the development of typical working memory process in children speaking two different languages characterized by different orthographic consistency. Methods. 134 children, 93 Italian and 41 English, are evaluated twice through a test battery during a 12 months period. The effects of gender and age are assessed on each variable of the test. The ANOVA test is used to assess notable discrepancies between sub-groups of children and a series of distinct correlation and regression analyses are carried out on both samples in the two administration times in order to assess the relation between working memory and decoding functions in both lexical and sub-lexical components. The Italian sample, in the preschool phase, shows that the decoding abilities particularly activates the short-term visuospatial component and only in minor part the verbal elements. During the first learning phases, instead, the verbal parts prevail on the visuospatial ones. In the English sample, during the preschool phase, the phonological decoding seems to be predicted by the short-term verbal memory, whereas the direct lexical access by the visuospatial memory ability. Instead, during the first learning phases, the English children show to employ more visuospatial resources in phonological decoding and more cognitive resources in lexical access. Pupils reading in English employ mainly logographic strategies in word recognition, whereas Italian children seem to principally adopt serial decoding strategies. This research proves that a developmental modification of the working memory system, consonantly with the native language, occurs after the beginning of an intentional and regular exposure to education. Moreover it is proved that various systems participate in the acquisition of the reading abilities, depending on the developmental stage.

Keywords: Working memory, Reading disorder, Learning to read, Orthographic consistency
Efficacy and efficiency outcomes of a training to ameliorate developmental dyslexia using the online software Reading Trainer®

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ABSTRACT. In this study, the results of a sublexical and lexical treatment were presented, provided through Reading Trainer, a software integrated in the online platform RIDInet, but constantly monitored by a clinical expert. Thirty-four children with a diagnosis of Dyslexia were enrolled in the study. The results obtained in the accuracy and speed in reading a passage, lists of words and nonwords were analyzed with respect to a criterion of efficacy, corresponding to the expected change without specialized training, and according to a criterion of efficiency, corresponding to the change of syllables/second for each hour of training. Results show adequate values of efficacy and efficiency and significant impact on the reading fluency and accuracy, bringing further evidence of the validity of the treatment applied by using the Reading Trainer software.

SUMMARY. This study presents the results of a sublexical and lexical treatment provided through Reading Trainer™ software integrated in the online platform RIDInet, but constantly monitored by a clinical expert. Thirty-four children with a diagnosis of Dyslexia were enrolled in the study. The results obtained in the accuracy and speed in reading a passage, lists of words and nonwords were analyzed with respect to a criterion of efficacy, corresponding to the expected change without specialized training, and according to a criterion of efficiency, corresponding to the change of syllables/second for each hour of training. Results show adequate values of efficacy and efficiency and significant impact on the reading fluency and accuracy, bringing further evidence of the validity of the treatment applied by using the Reading Trainer™ software.

Keywords: Developmental dyslexia, Training, Software, Efficacy, Efficiency