Università Cattolica del Sacro Cuore di Milano

Dottorato di Ricerca in Psicologia

Ciclo XXX

SSD: M-PSI/01

Improving Reading Skills in Students with Dyslexia:

The Efficacy of a Rhythm-Based Training

Tesi di Dottorato di:

Alice CANCER

Matricola n. 4411553

Coordinatore: Chiar.mo Prof. Camillo Regalia

Anno Accademico: 2016/2017

Abstract

Developmental dyslexia (DD) is associated with deficiencies in temporal processing of auditory stimuli, depending on atypical oscillatory neural activity, that are considered to contribute to phonological and reading impairments. To induce a more accurate entrainment to the spectral properties of auditory stimuli in students with DD, we explored the possibility to synchronize speech prosody during reading with an external rhythmical auditory stimulation. Accordingly, an intervention program for DD, called *Rhythmic Reading Training* (RRT), was devised. Three test-training-retest studies supported the efficacy of this novel methodology on reading skills of both young and older populations of Italian individuals with DD. Study 1 showed that RRT yielded reading improvements in primary and junior high-school students with DD comparable to those of an intervention resulting from the combination of two already validated treatments for DD, with a slightly larger effect on reading speed. Moreover, phonological awareness and rhythm reproduction improved along. Study 2 explored RRT short- and medium-term effects when combined with a specific auditory training in children and preadolescents with DD, which were found to be comparable to those of a personalized multi-componential intervention. Finally, in study 3 RRT was successfully applied to an older population, namely undergraduate students with DD, also when in combination with a neuromodulation technique (namely, tDCS) boosting plasticity of the involved networks.

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Introduction

Developmental dyslexia (DD) is the best known and most studied among specific learning disorders, especially in school populations. Since its main behavioural manifestation is an impairment in the ability of reading, DD often hinders school learning, thus having negative consequences on academic achievement. Such adverse outcomes are typically associated with low self-efficacy (Lackaye & Margalit, 2006) and frequently lead to emotional and behavioural problems (Capozzi et al., 2008).

Considering DD prevalence in school population, which is estimated to range up to 17.5% in English-speaking countries (Démonet, Taylor, & Chaix, 2004), it is crucial to deliver effective interventions targeting dyslexia-related difficulties, thus boosting students' academic achievement, which, in turn, would act as a protective factor for mental health problems. Standard training methods for DD are often characterized by limitations, such as expensiveness, time commitment, tediousness of the activities, and long practice required for trainers to master the methodology.

In the attempt to overcome such limitations, a novel rhythm-based intervention, called *Rhythmic Reading Training* (RRT), was designed for improving reading skills of Italian students with DD. RRT includes a set of reading activities in which decoding tasks are embedded into rhythm synchronization exercises, implemented into a computerized program. Its rhythmical feature makes RRT more appealing and less tedious for participants, relative to standard interventions. Furthermore, the delivery of RRT requires neither a specific setting, nor homework assignments, and can be easily managed by most trainers after just a short practice.

The present dissertation aims at testing the effectiveness of such novel methodology in different conditions, by comparing it with other validated interventions

for DD and/or combining it with other techniques, such as neuromodulation (i.e., tDCS).

The first chapter presents the theoretical framework within which RRT was devised, linking dyslexia-related deficits to anomalies in the auditory perception of temporal components of sounds (Goswami, 2011; Goswami, Power, Lallier, & Facoetti, 2014), along with the hypothesis of a beneficial effect of rhythmic auditory training, which stemmed from it.

The second chapter reviews a collection of studies which measured the efficacy of auditory and musical interventions specifically devised for improving dyslexia-related difficulties. Results of such studies supported the hypothesis of a transfer effect of musical/auditory training to the language domain; Most studies indeed reported significant beneficial effects on reading and phonological abilities – also comparable to those of standard language-based interventions – in children with DD.

The third chapter includes a comprehensive description of RRT contents and features, together with the presentation of four preliminary studies aimed at addressing the program functioning and applicability.

In chapters 4-6, three experimental studies, designed to investigate the effect of RRT in both young and older populations of individuals with DD, are presented.

Finally, chapter 7 draws a comprehensive qualitative comparison across the seven reported studies, and thus general conclusions on RRT remedial effect.

The findings reported in the present dissertation support the hypothesis of the beneficial effect of rhythmic interventions for DD, and provide evidence of the successful application of the rhythmic approach to the Italian language and setting.