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Artificial grammar learning via visual and auditory modalities: a comparison between individuals with dyslexia and typically developed readers

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Introduction

Developmental dyslexia is commonly defined as a reading disability, a deficit in learning to spell and write, occurring in children despite normal intelligence, no sensory or neurological impairment, and conventional instruction and socioeconomic opportunity (Dilling, Mombour, & Schmidt, 1991; Folia et al., 2008; Habib, 2000; Shaywitz, 1998). It is generally accepted that dyslexia is characterized by developmental weaknesses in establishing phonological representations of speech whereby individuals with dyslexia have difficulty learning associations between how words appear in print and how they sound (Bradley & Bryant, 1983; Ramus et al., 2003; Snowling, 2001). However, this explanation does not account for the wide range of sensory, cognitive, and motor deficits also observed in dyslexia (Habib, 2000; Ramus et al., 2003).

Recently, many researchers claim that difficulties in word recognition reflect more general problems in cognitive processing. Research motivated by this hypothesis has attempted to define the basic cognitive deficits that form the root of widespread information processing problems in this population.

One area of research that has drawn considerable attention in recent years centers on the issue of whether readers with DD are characterized by implicit learning deficit (Bennett, Romano, Howard, & Howard, 2008; Folia, et al., 2008).

The implicit learning mechanism is innate and it allows the acquisition of structural regularities in the environment (Folia et al., 2008; Gomez, 1997; Pavlidou & Williams, 2014). Knowledge of the regularities in the external environment plays a central role in the workings of the human cognitive system. This knowledge enables the cognitive system to perform various tasks.

Many tasks are suggested in order to examine the implicit learning capability. Artificial grammar learning (AGL) is often used implicit learning task (Reber, 1967). In this

task, subjects are confronted with trains of letters (typically 3–7 letters long) which are formed according to an artificial grammar. In a training phase, these letters have to be remembered. In a subsequent test phase, subjects are asked to grammatical judgments on a set of letter trains they have not seen previously and that are either constructed according to the artificial grammar or contain violations of the grammatical structure. Typically, subjects are able to judge above chance level of the letter strings correctly without being able to tell the experimenter about the basis of their judgment.

The main purpose of the current study was to examine implicit sequential learning processes among individuals with DD compared to normal readers. Our basic assumption was that implicit learning processes underlie the acquisition of language and related to many linguistic skills, as reading and writing. Thus, a deficit in implicit learning might be found among individuals with DD. This research is divided into two experiments investigating the relation of implicit sequential learning and DD using a classic AGL task in visual and auditory modalities.

The first experiment included Twenty-nine participants. Of these, 10 were females, 14 were controls and 15 were individuals with DD . The participants' age ranged from 18 to 33. The second experiment included twenty-four participants, of these, 12 were females, 14 were controls and 10 were individuals with DD. The participants' age ranged from 19 to 35 (M = 27.12, SD = 3.91). For the purposes of the present experiment, the dyslexia condition was established by didactic assessment evaluating the reading problems. The didactic assessment was validated by reading tests that measured reading accuracy, reading fluency and decoding.

The results of both experiments indicate a significant difference between the groups, where the performance of participants with DD was worse than the performance of TD readers. Both experiments thus support the assumption of a deficit

in implicit sequential learning among individuals with DD (Bennett et al., 2008; Folia, et al., 2008).

The present study sought to contribute to the existing knowledge on implicit learning processes among individuals with DD by examining this issue within the context of AGL. We addressed this issue by exploring the performance of individuals with DD on AGL tasks using the two modalities which are assumed to be most extensively involved in reading, i.e. the visual and the auditory modalities. The results of these experiments suggest that while implicit learning appears to be a-modal for TD readers since they exceed chance level regardless of the modality, individuals with DD are in fact influenced by the modality of the stimuli.