Abstract

A wide-ranging conversation has taken place in research literature over the past few years, concerning dyslexia, its characteristics, and the difficulties that lie at its root. The dominant claim of the past forty years - that dyslexia stems from phonological processing difficulties - has now been joined by other findings, which suggest that dyslexia may stem from more generalized cognitive difficulties. One function that has been found to be related to reading acquisition is statistical learning, that is, the ability to recognize statistical patterns in successive stimuli. There is evidence that learners with dyslexia struggle with statistical learning; these struggles were identified during implicit learning tasks. These findings have led to the claim that learners with dyslexia will experience statistical learning challenges during implicit learning tasks, and not during direct or explicit instruction. And indeed, there is evidence that intentionally making learning tasks more explicit leads to improved statistical learning. Therefore, the goal of the current study is to examine statistical learning processes in both implicit and explicit learning tasks, while comparing learners with dyslexia to learners without dyslexia. It is extremely important to compare implicit and explicit statistical processing with learners with dyslexia, since it can foster better understanding of the challenges these learners face. It can also advance our understanding of how these learners grapple with implicit, rather than explicit, statistical learning tasks.

Recent research has addressed the question of assess the differences between implicit and explicit statistical learning. The distinction between implicit and explicit statistical processing has generally been assessed during the sequence-sorting stage; the number of correct answers is used as an objective measure of learners' ability. In the implicit task, the learner is exposed to practice sequences without any stated learning objective, without being aware of the structure of these sequences, and without the chance to explain what they learned. In the explicit task, on the other hand, learners are told ahead of time that their reading sequences are based on a pattern, in order to raise their awareness of the pattern and intentionality of the task. Learners are also able to present specific knowledge about patterns within the sequences. During the assessment stage, the number of correct answers is noted without access to the learner's awareness, or to the components of learning that the learner is acquiring during the course of the assessment. Still, some researchers have criticized the fact that objective performance tasks lose important information by ignoring participants' feelings and motivations throughout the sorting task - in other words, the participants' ability to determine the patterns in the sequences they read by identifying the feelings that guide their choices. These same researchers have found that participants' awareness of their own feelings and thought processes allows them to achieve higher levels of statistical learning during explicit tasks. Still, research has not yet been done on subjective measures among learners with dyslexia during explicit statistical learning tasks - especially in the visual modality, in which the distinction between implicit and explicit statistical learning tasks is particularly important (because of the difficulties that learners with dyslexia face when completing these tasks).

Therefore, the current study measures both implicit and explicit statistical learning tasks among high school graduates with dyslexia. It includes both objective and subjective methods of assessing the various learning processes employed during a visual artificial grammar learning task. The explicitness of the task was increased by a direct instruction to participants to search for patterns; a questionnaire was also used in order to assess the participants' subjective feelings and motivations during the task.

Participants were divided into two groups: one included an implicit artificial grammar task with no direction to search for patterns, while the other included an explicit artificial grammar task and an instruction to search for patterns within the sequences. 32 high school graduates participated in the first group: 17 in the control group, and 15 in a group of learners with dyslexia. The second group was comprised of 27 high school graduates: 14 in the control group, and 13 in the group of learners with dyslexia. Participants' ages ranged between 20 and 35.

The study's results showed that in the objective measures - that is, participants' success with artificial grammar tasks - readers with dyslexia were able to learn the statistical patterns during both implicit and explicit tasks. However, there were significant differences in their performance on the two types of tasks: their performance on explicit tasks was significantly higher than their performance on implicit tasks. On the other hand, readers without dyslexia showed no significant performance differences between implicit and explicit tasks. These findings indicate that learners with dyslexia have a difficulty with implicit statistical processing. However, when instructed to search for patterns, readers with dyslexia are able to complete this task at an accuracy rate higher than guessing. These findings support the claim that the central challenge for readers with dyslexia lies in implicit, rather than explicit, statistical learning. They also support the theory that the statistical learning mechanism is not a domain-general mechanism, but rather a mechanism that combines separate learning processes, expressed in differences between implicit and explicit learning - as seen among learners with dyslexia.

Subjective measures about the learning task were gathered by attributing each respondent's answers about the degree of explicitness of the knowledge that respondent used. The study's findings yielded an interaction between the research groups, by associating the responses from the two different task types. No significant differences were found between responses on implicit and explicit tasks among readers without dyslexia; in contrast, graduates with dyslexia associated their responses with higher levels of explicitness during the explicit tasks than during the implicit task. These findings strengthen the results of the objective measures, showing that even in subjective measures, readers with dyslexia report a higher level of explicitness during explicit statistical learning tasks than during implicit statistical learning tasks. This demonstrates that a direct instruction to search for patterns allows learners to access greater awareness of patterns in an artificial grammar task. This helps them increase their awareness of patterns, compensate for difficulty, and perform as well as non-dyslexic readers.

Difficulty in learning implicit patterns during an artificial grammar task, as found in the present study, shows that even though readers with dyslexia are capable of learning statistically patterned sequences, their learning is limited and reflects a failure to develop automaticity. This stems from a struggle to monitor for meaning and internalize rules. On the other hand, explicitly increasing learners' awareness of rules can compensate for this struggle during implicit tasks.

The present study is important because it underlines the need to distinguish between implicit and explicit learning tasks as they relate to statistical learning among readers with dyslexia. It also emphasizes the importance of using subjective measures to raise participants' awareness during artificial grammar tasks, as these measures can deepen understanding of statistical learning among learners with dyslexia. The results of this study underscore the challenges that readers with dyslexia face during implicit statistical learning tasks; they also broaden our understanding of the importance of

accessing readers' subjective experiences during learning. These findings emphasize the need for intentionally directed learning, in order to compensate for the challenges faced by readers with dyslexia and assist them in acquiring an awareness of statistical patterns while learning to read.