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# Neuropsychological intervention of dyslexia has a positive effect on aspects of psychological well-being in young adults - a randomized controlled study

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## ABSTRACT

Effectiveness of individual and group-based neuropsychological intervention on aspects of psychological well-being of dyslexic adults was evaluated. Dyslexic young adults ( $n = 120$ ) were randomly assigned into individual intervention, group intervention, or wait-list control group. Both interventions focused on cognitive strategy learning, supporting self-esteem, using psychoeducation, and in group format also peer support. Cognitive and behavioral strategies, mood states, quality of life, and self-esteem were assessed via self-report questionnaires at baseline, after the intervention/wait-list control time at five months, and ten months. Results indicated that the neuropsychological interventions had a positive effect on self-evaluated cognitive and behavioral strategies, especially in increasing success expectations and to a lesser degree in diminishing task-avoidance and in group intervention in diminishing social pessimism. The interventions also improved cognition-related quality of life, and to a lesser degree, self-esteem. These results indicate that structured neuropsychological interventions can positively affect self-evaluated psychological well-being, especially on cognitive and behavioral strategies. Considering the secondary

consequences of dyslexia, support among young adults is often needed beyond the cognitive and reading-based challenges dyslexia poses.

## INTRODUCTION

Developmental dyslexia is one of the most common learning disabilities. It is defined by poor reading skills, including problems with accurate and/or fluent word recognition and decoding (International Dyslexia Association, 2002). Dyslexia is often accompanied also with difficulties in various cognitive areas, including phonological processing (Laasonen et al., 2012b; Melby-Lervag, Lyster, & Hulme, 2012), attention (Hari, Renvall, & Tanskanen, 2001; Laasonen et al., 2012a), and processing speed (Catts et al., 2002; Peter, Matsushita, & Raskinda, 2011). However, the consequences of dyslexia are commonly not limited to cognitive disabilities alone but tend to affect psychosocial well-being as well (Livingston, Siegel & Ribary, 2018).

All too common failures at school resulting from cognitive difficulties can lead to negative self-image and negative beliefs of oneself as a learner. Unwanted dyslexia-related effects on psychological well-being identified in the research include problems with self-esteem (McNulty, 2003; Riddick, Sterling, Farmer, & Morgan, 1999), increased anxiety (Carroll & Iles, 2006; Carroll, Maughan, Goodman, & Meltzer, 2005; Wilson, Armstrong, Furrie, & Walcot, 2009), and increased risk for depression (Aro et al., 2019; Maag & Reid, 2006; Maughan, Rowe, Loeber, & Stouthamer-Loeber, 2003; Wilson et al., 2009). Even high-achieving adults with dyslexia continue to demonstrate impairments that are likely to affect success in higher education and put them at a disadvantage during their studies (Bradshaw, Woodhead, Thompson, & Bishop, 2021).

Accordingly, university students with dyslexia have been reported experiencing lower self-esteem, and higher depression scores than controls, along with higher levels of social and attentional problems and somatic complaints (Ghisi, Bottesi, Re, Cerea, & Mammarella, 2016). In another study, behavioral problems (aggressive behaviour and delinquency) together with dyslexia

predicted delayed graduation from upper secondary education (Hakkarainen, Holopainen, & Savolainen, 2016). Dyslexia-related problems often continue also in working life (de Beer, Engels, Heerkens, & van der Klink, 2014; Madaus, 2008), and the influence of dyslexia is mainly negative (de Beer et al., 2014). Among Finnish subjects diagnosed with dyslexia as a child and having their reading disability still evident in adulthood, unemployment was almost four times that of controls (Eloranta, Närhi, Eklund, Ahonen, & Aro 2019), and especially slow adult-age reading was associated with long-term unemployment (Kortteinen, Eklund, Eloranta, & Aro, 2021). Restrictions in the possibilities of activities and participation due to a disability can also affect the quality of life (Sharfi & Rosenblum, 2014).

### Support for adults with dyslexia

Since dyslexia has such broad effects on an individual, adequate support of adults suffering from it needs to concentrate not only on the cognitive difficulties but on related psychosocial challenges as well. One way of support is to embrace the factors known to contribute to success in life in people with dyslexia. In this context, personal attributes, such as self-awareness, proactivity, perseverance, adaptability, goal setting, learned creativity, and presence, as well as use of effective social support systems, have been brought up (Gerber, 2002; Goldberg, Higgins, Raskind, & Herman, 2003). In an Australian study, adolescents with learning disabilities have been shown to use more nonproductive coping styles than the average population (Firth, Greaves, & Frydenberg, 2010). People with dyslexia with more advanced planning and metacognition report higher job satisfaction levels and self-efficacy (Leather, Hogh, Seiss, & Everatt, 2011). Self-efficacy, as an individual's belief in his or her innate ability to achieve goals, is likely to increase motivation, engagement, and perseverance to succeed (Bandura, 1997). In study-related situations, adaptive cognitive achievement strategies include a high degree of task involvement and persistence in the face of obstacles (Onatsu-Arviolommi, Nurmi & Aunola, 2002; Aunola, Stattin & Nurmi, 2000). Workable cognitive strategies, like not procrastinating on getting involved with tasks at school or work and believing in

one's possibilities of succeeding in future tasks, could create a positive cycle making succeeding in future tasks more likely. Encouraging in creating and using social support systems effectively could also endorse better handling of study or work-related tasks (Goldberg et al., 2003; Nalavany, Carawan & Rennick, 2011). In a new study environment, the cognitive and social strategies of young adults contributed to individuals' success in dealing with both the academic and interpersonal challenges they faced (Eronen, 2000). Despite showing high stability, the strategies were susceptible to change due to environmental feedback (Eronen, 2000).

Self-esteem is essential to psychosocial functioning in adulthood, and it has been reported to be low among adults with dyslexia (McNulty, 2003; Nalavany & Carawan, 2011; Riddick et al., 1999). Especially academic self-esteem has been found to be low in children with dyslexia (Terras et al., 2009), and failing to reach expected academic goals can be damaging for self-esteem and identity of young adults as well (Lithari, 2019; Sumner, Crane, & Hill, 2021). Postsecondary students with learning disabilities have been suggested to experience continuing academic stress in college because of relatively lower implementation of learning strategies, low levels of academic motivation, metacognitive self-regulation, and low metacognitive awareness (see meta-analysis Klassen, Tze, & Hannok, 2011). Academic self-esteem is also associated with internalizing difficulties (anxiety and depression) (Terras et al., 2009), and these difficulties tend to continue into adulthood (Klassen et al., 2011). Since low self-esteem is associated with difficulties in multiple domains (i.e., social, emotional and behavioral), it has been suggested as an essential target in minimizing the negative consequences of dyslexia (see review Livingston et al., 2018).

### Neuropsychological rehabilitation

Neuropsychological rehabilitation aims to decrease the disadvantages caused by brain dysfunctions and to increase everyday coping despite the possibly lingering deficits. Knowledge of the neural bases of cognition and behavior is used when training the impaired cognitive functions and practicing new strategies and using different aids to improve coping. In neuropsychological

interventions, better functioning is also supported via enhancing psychological adaptation by offering psychological support and increasing self-understanding and acceptance. (Sohlberg & Mateer, 2001; Wilson, Gracey, Evans, & Bateman, 2009). Increasing self-understanding and acceptance as well as supporting planning and metacognitive skills can possibly have positive effects on, self-esteem and self-advocacy. Increasing the knowledge on one's strengths and weaknesses related to the learning disability can make communicating the disability easier. Reorganizing the environment and taking advantage of assistive technology and accommodations can offer crucial help in coping with dyslexia (de Beer et al., 2014). Practices in administering neuropsychological interventions vary between different countries. In Finland, neuropsychological rehabilitation is part of the healthcare system and can be offered regardless of participants' life situations. For students with learning disabilities, it is usually offered if special education as a means of support is not enough or the problems are affecting areas beyond academic skills per se (for example, executive functions, concentration, psychological adjustment, etc.).

### Dyslexia interventions

Studies on neuropsychological interventions of dyslexia generally focus on children (e.g. Goldstein & Obrzut, 2001; Joly-Pottuz, Mercier, Leynaud, & Habib, 2008; Robertson, 2000; Zygouris, Avramidis, Karapetsas, & Stamoulis, 2018), or computerized training of cognitive domains, such as, phonological processing, and visual processing or attention, with restricted use of holistic support (e.g., Cancer, 2017; Lorusso, Facoetti, Paganoni, Pezzani, & Molteni, 2006; Lorusso, Facoetti, & Bakker, 2011). For older students with dyslexia, a neuropsychological rehabilitation program for improving executive functions has been developed, but efficacy studies are still needed (de Lima, Azoni, & Ciasca, 2017).

More commonly, interventions for dyslexia focus on different aspects of reading skills. For children, phonics interventions have shown to be more effective until grade one, after which comprehension and mixed interventions tend to be associated with more significant effect sizes

(Galuschka et al., 2020). Spelling interventions for adults are not common. A reading-focused intervention for adults produced significant gains in reading rate, passage comprehension, and spelling (Kitz & Nash, 1992), but no control group was used. An intervention more closely resembling neuropsychological rehabilitation included 60 unemployed adult participants in a 5-month full-time educational program aiming to improve reading, writing, verbal memory, self-esteem, and flexibility of perspectives (Jensen, Lindgren, Andersson, Ingvar, & Levander, 2000). Performance in the intervention group improved significantly in spelling, decoding, self-confidence, and flexibility compared to the controls. Because of the full-time schedule for five months, this kind of a program would be difficult to implement among people studying or working.

Effects of neuropsychological interventions on cognitive aspects of dyslexia were evaluated in another study of this project. Compared to the control group, both individual and group-based neuropsychological interventions had a positive effect on a measure of processing speed and attention and the gains from the intervention remained after a 5-month follow-up (Authors, 2020).

In self-reported cognitive symptoms, a positive trend was evident in self-reported reading habits and minor self-evaluated benefits reaching up to 15 months post-intervention were found (Authors, 2020). Other research on the effectiveness of neuropsychological intervention for adults with dyslexia is not known to the authors. Also, research on psychosocial interventions for adults with dyslexia is sparse (Costantini, Ceschi, & Sartori, 2020).

Because of the possibility of supporting both cognition and psychological well-being, and the positive effect that has been shown concerning other patient groups (Cicerone et al., 2005; Cicerone et al., 2011), we wanted to find out the possible effectiveness neuropsychological intervention has on aspects of psychological well-being among young adults with dyslexia. The neuropsychological interventions used in this study aimed to help in coping with the immediate and secondary problems that come along with dyslexia. For example, adopting new strategies to cope with dyslexia-related difficulties could potentially give a better sense of mastery and increase self-confidence in

successfully handling future tasks. Managing better with dyslexia-related difficulties could also potentially have a positive effect on self-esteem and quality of life.

In this study, we focused on possible effects the interventions have on the participants' psychological well-being, including self-reported cognitive and behavioral strategies, quality of life, mood, and self-esteem. The pre-specified hypothesis was that both interventions show positive effects on psychological well-being compared to the control group. The additional research question was whether either individual or group-based neuropsychological intervention is more effective than the other.

## METHODS

### Participants

The recruitment process was continuous for 23 months, from November 2012 until August 2014.

Data collection ended in September 2016. The participants were recruited by distributing information about the study via multiple different channels, including health care units, educational institutions, associations related to learning difficulties, etc. The participants met the following inclusion criteria: (1) 18-35 years old during the year they were randomized to the study. (2) Clinically confirmed developmental dyslexia based on a clinical neuropsychological assessment and a medical examination by a physician specialized in phoniatrics. Dyslexia was confirmed based on the participants' performance in five tests from two Finnish test batteries for dyslexia (Dyslexia Screening Test for Adolescents and Adults; Holopainen, Kairaluoma, Nevala, Ahonen, & Aro, 2004, and Reading and Writing Test for Adolescents and Adults; Nevala, Kairaluoma, Ahonen, Aro, & Holopainen, 2006). (3) Limited abilities in studies, work, or employment related to dyslexia. (4) Subjective and objective need for intervention because of dyslexia. (5) Native language was Finnish. (See about inclusion criteria in more detail in Authors, 2020.) The decision concerning



criteria 3 and 4 was made using clinical evaluation based on a systematic interview and the neuropsychological examination.

The exclusion criteria evaluated via an interview and questionnaires prior to assessments were: 1) neurological illnesses, 2) other learning disabilities than dyslexia, 3) diagnosed or suspected ADHD, 4) psychiatric diagnoses, 5) severe depressive symptoms, 6) alcohol or drug abuse, and 7) neuropsychological intervention received at the age of 16 or later (see in more detail Authors, 2020).

Exclusion criterion was set for verbal comprehension and perceptual reasoning to exclude possible developmental or other problems in language or non-verbal performance in the neuropsychological assessment. The exclusion criterion was general cognitive capacity being less than 80 points on the Wechsler Adult Intelligence Scale – Fourth Edition (WAIS-IV; Wechsler, 2008, 2012) in either Verbal Comprehension Index or Perceptual Reasoning Index estimated by four subtests (Similarities, Vocabulary, Matrix Reasoning, Block Design).

The mean age of the participants was 25 years ( $SD = 5.8$ ), and 80 percent were women. The highest on-going education or highest completed education at the time of enrollment to the study was at least high school level for 82 percent of the participants, and 53 percent studied or had completed a degree in college or university. Regarding current life-situation, 85 percent were either employed or studying. The mean score for cognitive performance measured by WAIS-IV (Wechsler, 2008, 2012) was 100.3 points ( $SD = 12.4$ ).

All participants gave their written informed consent, and the study protocol was approved by the ethics committee of the Helsinki Uusimaa Hospital district. Participants were randomly assigned into individual intervention, group intervention, or wait-list control group by a blinded statistician using a stratified random number table. The randomization was stratified according to age (18–26 years vs. 27–35 years), gender (female vs. male), and education (primary and secondary education

vs. higher education). Of the 120 randomly assigned participants, 118 were assessed at baseline (40 in individual and, 39 in group intervention, 39 in control-group), 115 were assessed at five months (39 in individual and, 37 in group intervention, 39 in control-group), and 106 at ten months (38 in individual and, 35 in group intervention, 33 in control-group). For the number and reasons for incomplete data, see Authors, 2020.

## Measures

Participants' self-reported cognitive and behavioral strategies, quality of life, mood states, and self-esteem were measured via questionnaires administered in Finnish.

The Strategy and Attribution Questionnaire (SAQ; Nurmi, Salmela-Aro, & Haavisto, 1995) is a self-report measure of cognitive and behavioral strategies. The version used in this study was a shortened version of 20 questions using a 7-point-scale (from 1 = “*strongly disagree*” to 7 = “*strongly agree*”) to assess four subscales. The reliability of these subscales (Cronbach's  $\alpha$ ) has in a previous study been ranging from 0.57 - 0.81 (Vahtera, 2007). The reliabilities (Cronbach's  $\alpha$ ) of each scale measured from our sample are mentioned after introducing the scale. The *Success expectation* subscale measures the extent to which people expect success and are not anxious about the possibility of failure (e.g., “When I go into new situations, I usually expect I will manage”). The observed reliability in our sample was 0.76. The *Social pessimism* subscale measures the extent of anxious feelings towards social situations and concerns over other people's feelings towards oneself (e.g., “No matter what I do, people have a negative opinion of me”). The observed reliability in our sample was 0.67. The *Social optimism* subscale measures the extent of positive expectations towards social situations (e.g., “When things do not go smoothly, it is best to talk it over with friends”). The observed reliability in our sample was 0.58. The *Task-avoidance* subscale measures the extent to which people tend to behave in a way that prevents them from, rather than helps them in carrying out a task (e.g., “If I have a difficult task before me, I notice that often I do not really

try”). The observed reliability in our sample was 0.79. In the SAQ, individual subscales are analyzed, and the scale does not have a total score.

The Quality of Life after Brain Injury Overall Scale (QOLIBRI-OS; von Steinbuechel et al., 2012) assesses the quality of life using six questions on a 5-point-scale (from 0 = “*Not at all*” to 4 = “*Very*”). The reliability of the scale (Cronbach’s  $\alpha$ ) has been reported as 0.86 (von Steinbuechel et al., 2012), and the observed reliability in our sample was 0.76. The instruction for answering is, “*These questions are about how you feel overall now (including the past week).*” Areas covered by the questionnaire include physical condition, cognition, emotions, function in daily life, personal and social life, and current situation and future prospects. The total scale was analyzed as well as each individual question separately since all the individual questions measure a unique area of life quality.

The Profile of Mood States (POMS; McNair & Lorr, 1964; McNair, Lorr & Droppleman, 1992) version used in this study is a Finnish version containing 38 adjectives (e.g., “active”, “unhappy”, “annoyed”), that are rated on a 5-point-scale (from 0 = “*Not at all*” to 4 = “*Extremely*”) (Hänninen, 1989; for a 37 item English version see Shacham, 1983). The reliability (Cronbach’s  $\alpha$ ) of the scales in the English 37 item version has been ranging from 0.80 to 0.91 (Shacham, 1983). The observed reliability (Cronbach’s  $\alpha$ ) for the whole scale in our sample was 0.92. The question formulation concerning each adjective is “*Choose the option that best describes your feelings over the past week.*” The total score was analyzed.

In Rosenberg’s Self-Esteem Scale (Rosenberg, 1965), self-esteem is assessed using 10 questions on a 4-point-scale (from 1 = “*Strongly agree*” to 4 = “*Strongly disagree*”). Previous studies have reported reliabilities (Cronbach’s  $\alpha$ ) for the scale ranging from 0.72 to 0.88 (Gray-Little et al., 1997; Robins et al., 2001). The reliability (Cronbach’s  $\alpha$ ) in our sample was 0.87. The scale includes five positive and five negative statements concerning the self (e.g., “On the whole, I am satisfied with myself”). The total score was analyzed.

## Study Procedure

The assessments were performed at baseline, at five months (end of intervention or end of waiting period), and ten months (after follow-up for the intervention groups and after intervention for the wait-list control group). The assessments were timed identically in individual and group interventions having baseline assessment 1–14 days before the first intervention session and follow-up assessment 1–14 days after the last intervention session. The study protocol was published in advance (ClinicalTrials.gov identifier: NCT01930500). The allocation sequence was concealed from the assessing psychologist, and the participants were advised not to mention which group they attended.

## Intervention

The therapists giving the interventions were registered as qualified neuropsychologists eligible to administer neuropsychological rehabilitation by the Social Insurance Institution of Finland. The therapists were given an intervention manual designed for this study, and they were instructed on the administration of the intervention. This was not a strictly manualized intervention, and the therapists were expected to use their skills in determining which exercises would suit which participants, as well as, make up content related to the participants' life situations using materials, for example, from their school or work assignments. Adherence to the intervention protocol was assured by having monitoring discussions with the therapists during the interventions. Two experienced therapists administered most individual interventions and all the group interventions (N = 90 participants).

The neuropsychological interventions aimed at improving performance in cognitive tasks as well as enhancing psychological well-being. The intervention model had 12 sessions lasting over a five-month period and a fixed basic structure, with each session having its own topic. The topics included the following: Setting goals, psychoeducation on dyslexia and learning disabilities, reading

and writing strategies and aids, memory strategies, foreign language learning strategies, strategies and aids for improving attention and concentration, supporting self-esteem and promoting self-knowledge, relaxation methods, and stress management, mathematics, plans for future and evaluating the attainment of goals (for more specific description, see Authors, 2020). All sessions had specific materials and home assignments that were used by all therapists. The home assignments included a summary of the handled topics, and the participants were, for example, encouraged to implement the learned strategies in their study or work situations and report how they seemed to work for them. In individual sessions focusing content according to the participants' needs and neuropsychological profile was allowed as long as all the mentioned topics were at least briefly covered, and the focused topic was among the regular content (i.e., more focus on problems in reading than writing). The group intervention session lasted for two hours, thus being half an hour longer than the 1.5-hour-long individual session. The slightly longer time was due to the fact that in a group of ten people, the 1.5 hours was not enough to cover the topics. Common principles and neuropsychological rehabilitation methods were used, including cognitive and psychological support and reorganizing the environment (Sohlberg & Mateer, 2001; Wilson, Gracey, Evans, & Bateman, 2009). Cognitive tasks concerning for example, reading, planning, or memory performance were utilized in both interventions to train new strategies and to improve metacognition. Other methods included psychoeducation and offering psychological support to better cope with dyslexia. All participants received recommendations for accommodation in their work or studies and were introduced to aids designed to better cope with dyslexia (for example, audiobooks, text-to-speech -software, etc.). The group intervention also offered the possibility for peer support. Compliance with interventions was 100 percent in individual intervention, and in group intervention, 78 percent attended at least 75 percent of the sessions (see more specifically about compliance in Authors, 2020).

## Statistical Analyses

Group differences in baseline characteristics were analyzed using the Pearson chi-square test and one-way analyses of variance (ANOVA). Intervention outcomes concerning the questionnaires were analyzed using a linear mixed model (random intercept model; Singer & Willet, 2003), assessing possible differences over time (baseline, five months, and ten months), possible differences between groups (individual intervention, group intervention, and wait-list control), and the interaction between time and group. Bonferroni correction was used in all pairwise comparisons. The effect size was estimated using a formula suggested by Snijders and Bosker (1999, pp. 102-103). For those variables where a significant change at group level was found using the linear mixed model analyses, the significance of the changes at individual level was assessed by calculating reliable change (RC). It was calculated using a formula suggested by Jacobson & Truax (1991),  $[RC = (\text{measurement 2} - \text{measurement 1})/S_{\text{diff}}$  where  $S_{\text{diff}} = \sqrt{(2 * [SEM]^2)}$ ]. A confidence level of 95 percent indicating a significant change in one-sided testing was used (Duff, 2012). The analyses were performed using IBM SPSS Statistics program version 25.0.

## RESULTS

### Baseline comparisons

There were no statistically significant differences between the intervention groups and the control group in any of the background variables, including age, gender, educational level, and cognitive performance, see in more detail Authors, 2020. There were no statistically significant differences at baseline between the intervention groups and the control group in the self-report measures (for *M/SD*, see Table 1 and Table 2).

Change in cognitive and behavioral strategies, quality of life, mood states, and self-esteem

Change in cognitive and behavioral strategies

Using a linear mixed model analyses, there was a significant time x group interaction between the intervention groups and the control group in the SAQ subscale of Success expectation ( $F_{4,214} = 3.82$ ,  $p = .005$ ) (Table 1). The effect size for the fixed effects of the whole model was  $R_1^2 = .0294$ . Success expectations increased in group intervention significantly during the intervention from baseline to first follow-up at five months ( $p = .012$ ), and the result remained stable also during the follow-up period after intervention from five months to ten months. The changes in the individual intervention or the control group were not significant (Fig. 1). To evaluate the possible statistical and clinical significance of the observed changes at individual level, reliable change was calculated. At the first follow-up at 5 months seven (19.4 %) of the group intervention participants demonstrated reliable positive change at the 95 percent confidence level. In the control group one (2.6 %) and in the individual intervention one (2.6 %) participant demonstrated reliable positive change at the 95 percent confidence level at the 5-month follow-up. [INSERT TABLE 1 HERE]. [INSERT FIGURE 1 HERE].

There were no other significant time x group interactions between the intervention groups and the control group in the other SAQ subscales. However, in the SAQ subscale of Social pessimism, the interaction between the intervention groups and the control group came extremely close to significance ( $F_{4,214} = 2.39$ ,  $p = .052$ ) (Table 1). A statistically non-significant trend in the right direction was observed concerning social pessimism, which decreased in group intervention from baseline to first follow-up at five months ( $p = .16$ ) while remaining stable in individual intervention and control group during that time. For group intervention, the result remained stable during the follow-up period after intervention from five months to ten months. There were no significant changes in the individual intervention or the control group from five months to ten months.

As a smaller finding, a significant difference in time ( $p = .005$ ) was evident in the SAQ subscale of Task-avoidance over the three time-points (0, 5, and 10 months). The difference resulted from a significant decrease of task-avoidance in individual and group interventions from baseline to second follow-up at ten months (individual  $p = .048$ , group  $p = .003$ ). In the control group, there were no significant changes (Fig. 2). To evaluate the statistical and clinical significance of the observed changes by the second follow-up at individual level, reliable change was calculated. At the second follow-up at 10 months, seven participants (20 %) in group intervention and four (10.5 %) in individual intervention demonstrated reliable positive change at the 95 percent confidence level. In the control group one participant (3 %) demonstrated reliable positive change at ten months at the 95 percent confidence level. [INSERT FIGURE 2 HERE].

#### Change in quality of life

In the total QOLIBRI-OS score, the time x group interaction was not significant ( $F_{4,214} = 1.29$ ,  $p = .276$ ) (Table 2). When looking at each of the six individual components measured, all of which measure one specific component of quality of life, the time x group interaction concerning cognition (“Overall, how satisfied are you with how your brain is working, in terms of your concentration, memory, thinking?”) was statistically significant ( $F_{4,216} = 2.82$ ,  $p = .026$ ). The effect size for the fixed effects of the whole model was  $R_1^2 = .040$ . Perceived satisfaction with cognitive functioning increased in individual intervention significantly during the intervention from baseline to first follow-up at five months ( $p = .017$ ). The result remained stable also during the follow-up period after intervention from five months to ten months. Perceived satisfaction with cognitive functioning increased in group intervention significantly from baseline to second follow-up at ten months ( $p = .030$ ). In the control group, there were no significant changes in this component of quality of life (Fig. 3). [INSERT TABLE 2 HERE] [INSERT FIGURE 3 HERE]



### Change in Mood symptoms

There was no significant time x group interaction in the POMS questionnaire's total score between the intervention groups and the control group ( $F_{4,214} = 2.11, p = .081$ ) (Table 1). The mean baseline score for the participants in the whole POMS questionnaire was 39.8 points (SD = 17.5), which is 26.2 percent of the maximum score (152 points).

### Change in self-esteem

There was no significant time x group interaction between the intervention groups and the control group in the Rosenberg Self-Esteem Scale ( $F_{4,213} = 1.570, p = .183$ ) (Table 1). As a smaller finding, there was a significant main effect of time ( $p = .009$ ) over the three time-points (baseline, first follow-up at five months and second follow-up at ten months), resulting from the significant increase of self-esteem in individual intervention from baseline to first follow-up at five months ( $p = .027$ ) and in group intervention from baseline to second follow-up at ten months ( $p = .012$ ), the time-point five months after their intervention. Self-esteem did not change significantly in the control group over time, see Fig. 4. To evaluate the statistical and clinical significance of the observed changes at individual level, reliable change was calculated. At the first follow-up at 5 months, eight participants (21.6 %) in individual intervention and at the second follow-up at 10 months, eleven participants (31.4 %) in group intervention demonstrated reliable positive change at the 95 percent confidence level. In the control group five participants (12.8 %) at five months and six (18.2 %) at ten months demonstrated reliable positive change at the 95 percent confidence level.

[INSERT FIGURE 4 HERE]

## DISCUSSION

This study shows that neuropsychological intervention for dyslexia can have a positive effect on cognitive and behavioral strategies in young adults. Improvement in cognitive and behavioral

strategies compared to the control group was evident at group level, especially in expectations over succeeding in future tasks, which increased most prominently in group intervention. The gains from the intervention remained after the five-month follow-up. For group intervention, there was also a non-significant trend in diminishing pessimistic expectations towards social situations compared to the control group, and a positive finding at group level in both intervention groups in the quality of life concerning cognitive functioning. Additionally, as a smaller finding avoidance of tasks diminished, and self-esteem increased at group level in individual and group interventions.

Success expectations improved significantly at group level in group intervention. When looking at the changes at individual level, clinically significant positive change was evident in about one-fifth of the group intervention participants. Expecting to succeed even in a difficult task can increase motivation and predict success (e.g., Bandura, 1997). When expecting to do well, people tend to set task-related goals, make plans for their realization, and put effort in carrying them through (Eronen, 2000; Nurmi et al., 1995, Mischel, & Shoda, 1995). This, in turn, increases the probability of success in the task at hand and enhances further deployment of functional strategies (Eronen, 2000). In contrast, a person who anticipates failure usually tries to avoid the situation or behaves in ways that will provide excuses for possible failure (Berzonsky, Nurmi, Kinney, & Tammi, 1999; Eronen, 2000; Peterson & Seligman, 1984). This kind of behavior typically decreases the chances of success (Berzonsky et al., 1999; Cantor, 1990; Eronen, 2000).

Success expectations increased especially in group intervention. It could be speculated that perhaps seeing also other people with similar difficulties manage with different tasks could increase the optimistic expectations for one's own performance. The participants might have also received support from their peers during the intervention, which was one of the aims of group intervention. Both interventions seemed to help at group level also in diminishing avoidance of tasks expected to be difficult. When looking at the changes at individual level, clinically significant change in lessening of task-avoidance was evident in 10 to 20 percent of the participants in the intervention

groups. Ameliorating the challenges in getting started with the tasks one has (i.e., homework or work assignments) was among the intervention targets. When attacking the tasks at hand sooner than later, the potential to succeed is likely to grow. This, in turn, could enhance feelings of self-efficacy, a high-level of which has been linked to improving future performance (Elliot & Dweck, 2005; Liem, Lau, & Nie, 2008).

Group intervention also seemed to have a diminishing effect on social pessimism, which came very close to significance compared to the individual and control groups. The scale for measuring social pessimism includes questions like “I’m often alone, because I fear joining other people.” or “No matter what I do, people have a negative opinion of me.” Interacting with a group of people sharing the same difficulties and establishing a trusting and open atmosphere in the group may have diminished negative feelings associated with social situations. The individual intervention, where the interaction took place only with a professional, did not have significant effects on participants’ social attitudes.

In quality of life, the component concerning cognition improved significantly, while other components of life quality did not. A significant improvement was evident for both intervention types in participants’ satisfaction with how their brain is working in terms of concentration, memory and thinking. This finding is in line with the content of the interventions, where supporting memory, and concentration were a part of the interventions. In individual intervention, improvement reached significance at the end of the intervention, and in group intervention by the follow-up five months after the end of intervention. Changes in other components of satisfaction of life were not evident. One reason for that might be the fact that in these areas, satisfaction with one’s functioning was already at a higher level at the beginning of the interventions leaving less room for improvement.

Regarding self-esteem, no interaction was found between the individual intervention, group intervention and the control group over the measured time points, but as a smaller finding, a

significant increase in self-esteem was evident at group level in both intervention groups. At individual level, a clinically significant change was evident in roughly 20 to 30 percent of the participants in the intervention groups. Low self-esteem is among the most common psychological problems for individuals with developmental dyslexia (McNulty, 2003). In Western societies, academic attainment is emphasized over other forms of achievement (e.g., practical or creative), thus failing to reach expected academic goals can be damaging for self-esteem and identity of young adults (Lithari, 2019; Sumner et al., 2021). Supporting self-esteem was one of the general aims of these interventions. The therapists helped the participants to compartmentalize their disability by helping them see dyslexia as only one aspect of themselves and deliberately focusing also on the strengths and talents of each participant. Here again, increase in self-esteem evaluations was evident in individual intervention immediately at the end of the intervention, and in group intervention by follow-up at ten months.

Changes in mood were not evident. This could, for the most part, be explained by the participants having a low level of mood symptoms to begin with, leaving little room for improvement. The level of self-reported mood symptoms of the participants (26.2 % of maximum points) was fairly close to a non-clinical normative sample of American young adults (non-clinical sample total score in Profile of Mood States-Brief was 21.8 percent of maximum points, Yeun & Shin-Park, 2006). We controlled for severe depression and psychiatric diagnoses as an exclusion criterion, but milder mood symptoms were not a reason for exclusion. Based on earlier research literature (Aro et al., 2019; Maag & Reid, 2006; Maughan et al., 2003; Wilson et al., 2009), we were expecting to see more mood symptoms despite controlling for severe depression at enrollment, but the participants enrolled ended up being at a fairly high level concerning their mood.

The effectiveness of an intervention can be detected using group-level results or individual-level results. Sometimes an interaction can show an important result where improvement in the intervention group may be relatively small but without an intervention the situation in the control

group actually worsens. Then again, it is essential to single out whether there are clinically significant individual-level changes behind the significant group-level results, and the results are not made up of only minor, and as such perhaps clinically less significant changes in the individuals. Thus, in addition to group-level results we decided to check also individual-level results, since either way of analyzing can give differently valuable information. When a strict level of significance (95 %) for reliable change was selected, depending on the variable with significant group-level changes, around ten to thirty percent of the participants reached it. In the future it would be beneficial to try to find out who are those participants that primarily benefit from an intervention like this.

Individual and group interventions seem to have slightly different effects. In group intervention, success expectations increased, and social pessimism showed a decreasing trend, although not reaching significance. After both interventions, a diminishing of task-avoidance was reported as well as an increase in self-esteem. Both interventions also had a positive influence on cognition-related quality of life. The group intervention seemed to have wider-ranging effects in cognitive and behavioral strategies than the individual intervention. It seems possible that interacting in a group sharing similar experiences of living and managing with dyslexia has brought support in the beliefs of succeeding in future tasks as well as diminishing negative beliefs associated with social situations. In other regards, both interventions seemed to reach similar results. The content planned for this intervention was quite easily handled individually or in a group. Also, having relatively high-functioning participants might have helped them to take advantage of the intervention regardless of the format it was given in. Some changes seemed to reach significance in group intervention slower than in individual intervention reaching significance by the 10-month follow-up compared to reaching them by the end of the intervention in individual intervention. The found delayed effect in group intervention compared to individual intervention needs further studies.

This study aimed to meet the essential criteria for a high-quality study (van Tulder et al., 2003), and the drop-out rate was acceptable. Certain limitations must be considered when making conclusions based on the current study. The blinding of participants and therapists administering the intervention was understandably not possible. Also, the wait-list control group did not receive a placebo intervention while waiting, which means that the non-specific effects of interventions cannot totally be controlled for. The participants were relatively highly educated and comorbid, yet common conditions were ruled out by the exclusion criteria, such as other developmental learning disabilities than dyslexia, ADHD symptomology, or severe depressive symptoms. When looking at the results of the POMS, the level of mood symptoms was low. Together with the educational level and active life situations, one can say that the participants were relatively high-functioning dyslexics. This might have helped them in picking up and implementing new strategies and aids for use in daily life, and the results might not generalize to all young adults with dyslexia. On the other hand, participants with more dyslexia-related challenges could possibly have more room for improvement as a result of an intervention. There were also considerably more women than men participating in the interventions, which makes generalizing the results to the male population more challenging.

Acknowledging the often far-reaching secondary problems alongside the cognitive challenges, including problems with psychological well-being that have arisen during the childhood years of living with dyslexia, neuropsychological interventions could have their place as one means of support for young adults with dyslexia. Neuropsychological intervention could possibly help in ameliorating the cognitive challenges that dyslexia brings upon, as well as, support psychological well-being, for example, by strengthening self-esteem or encouraging in using more functional cognitive and behavioral strategies. It could be effective even with a relatively small amount of sessions administered. The studied neuropsychological interventions seem to have positive effects on aspects of psychological well-being. Individual and group interventions seem to have slightly

different effects, and group intervention showed slight advantages in offering wider-ranging support for cognitive and behavioral strategies. For improving psychological well-being, perhaps an ideal neuropsychological intervention for young adults with dyslexia could be one that combines both intervention formats giving personal support and helping to meet individual goals effectively while also enforcing positive social expectations and beliefs in one's capability of succeeding in future tasks.

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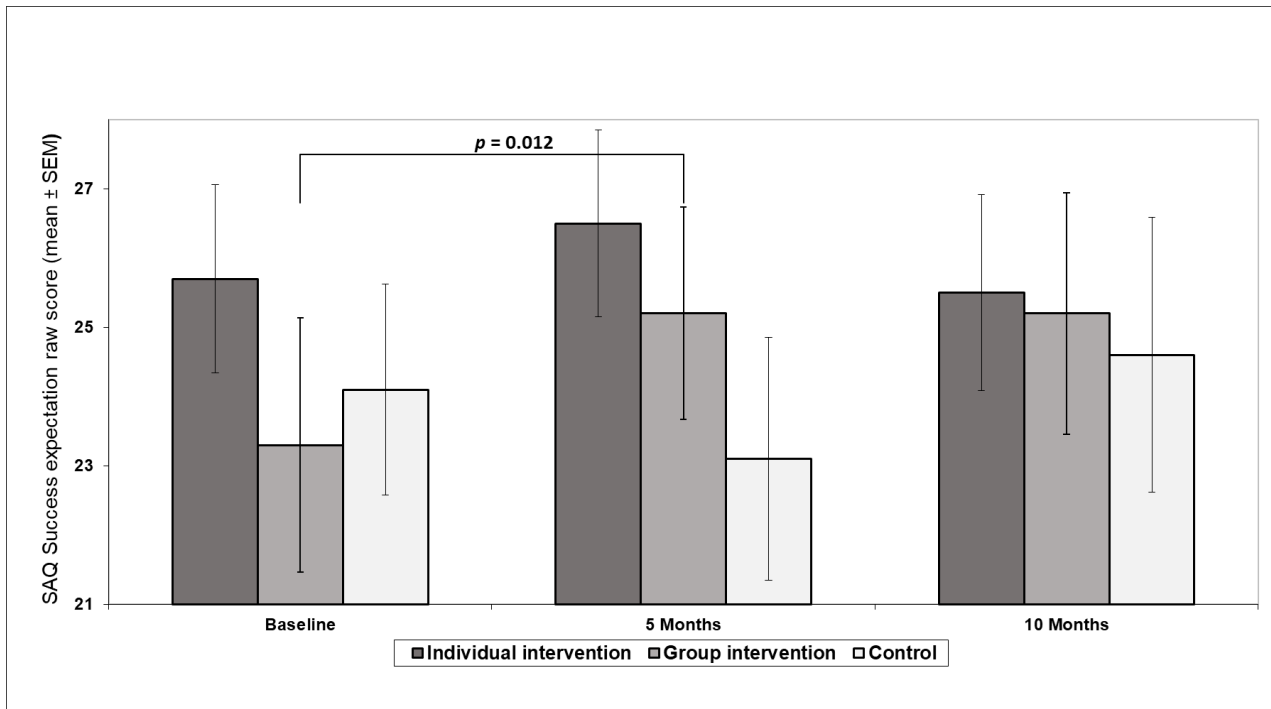


Figure 1. The changes in the Strategy Attribution Questionnaire (SAQ) Success expectation scale in individual and group-based neuropsychological interventions and wait-list controls in young adults with dyslexia. Measurement points are baseline (0 months), the end of intervention/wait-list control time (5 months) and the end of follow-up for the intervention groups/the end of intervention for wait-list control group (10 months). Based on post hoc analyses the change from baseline to 5 months was significant in group intervention at the  $p < 0.05$  level.

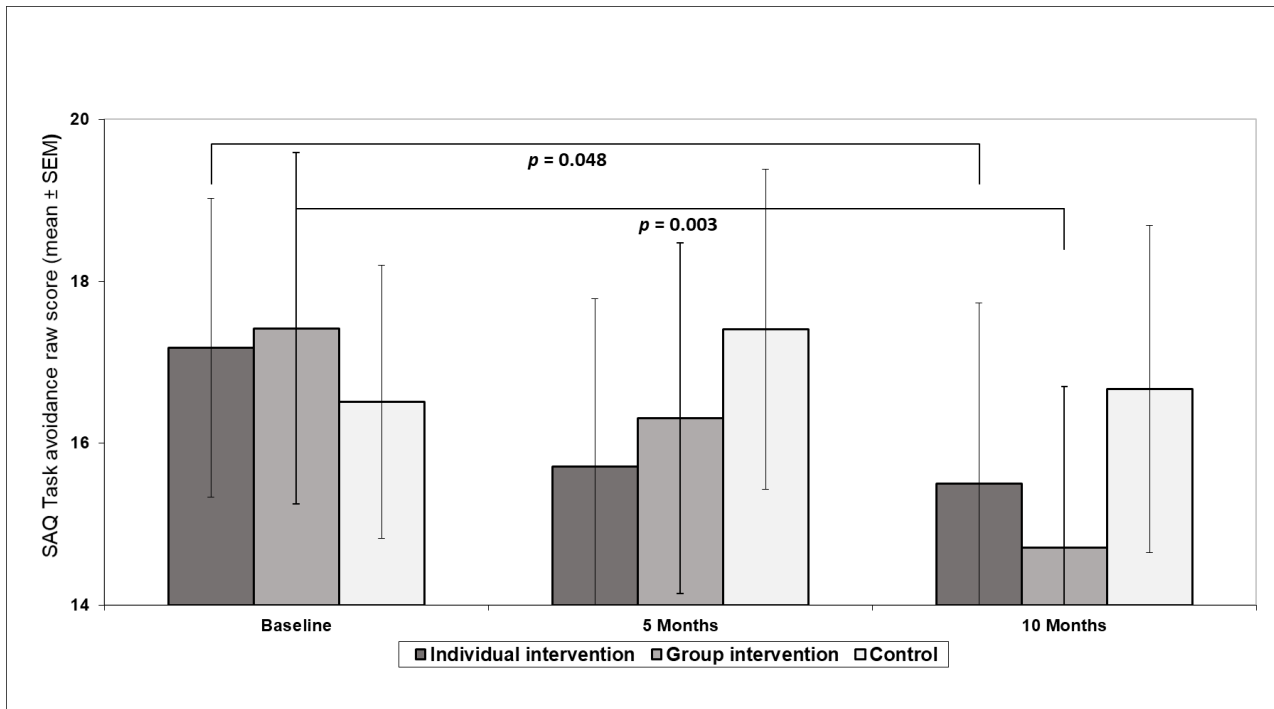


Figure 2. The changes in the Strategy Attribution Questionnaire (SAQ) Task Avoidance scale in individual and group-based neuropsychological interventions and wait-list controls in young adults with dyslexia. Measurement points are baseline (0 months), the end of intervention/wait-list control time (5 months) and the end of follow-up for the intervention groups/the end of intervention for wait-list control group (10 months). Less points equals a better result. Based on post hoc analyses the change from baseline to 10 months was significant in individual intervention at the  $p < 0.05$  level and group intervention at the  $p < 0.01$  level.

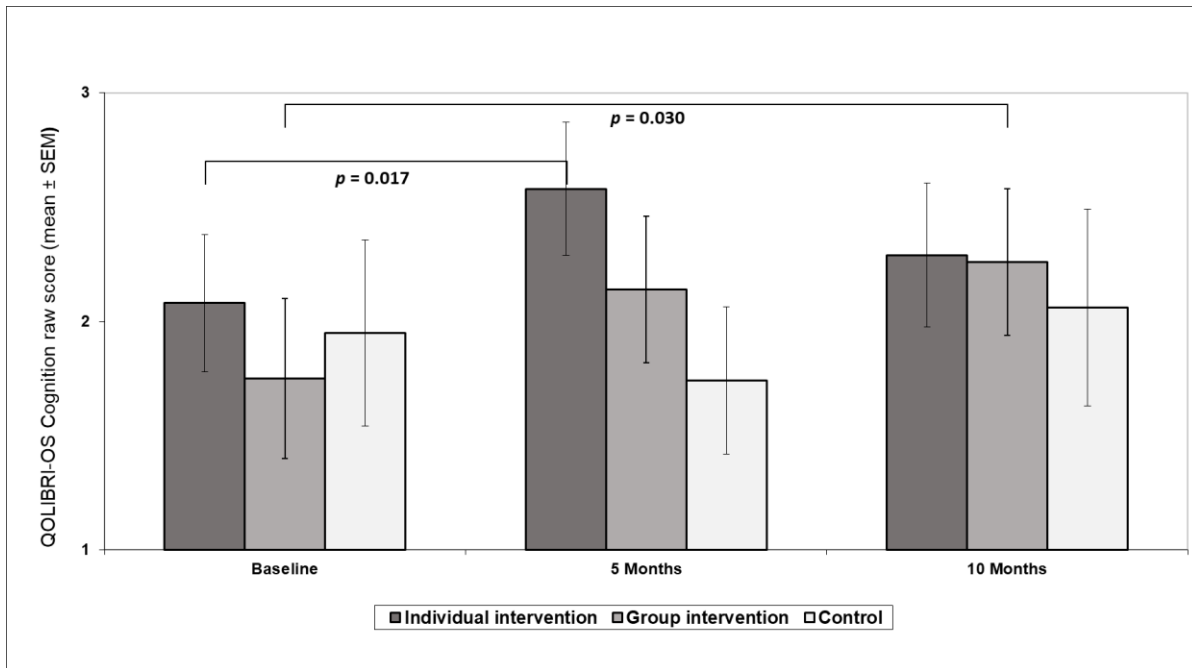


Figure 3. The changes in the Quality of Life after Brain Injury Overall Scale (QOLIBRI-OS) question “Overall, how satisfied are you with how your brain is working in terms of your concentration, memory, thinking?” in individual and group-based neuropsychological interventions and wait-list controls in young adults with dyslexia. Measurement points are baseline (0 months), the end of intervention/wait-list control time (5 months) and the end of follow-up for the intervention groups/the end of intervention for wait-list control group (10 months). Based on post hoc analyses the change from baseline to 5 months was significant in individual intervention and the change from baseline to 10 months was significant in group intervention at the  $p < 0.05$  level.

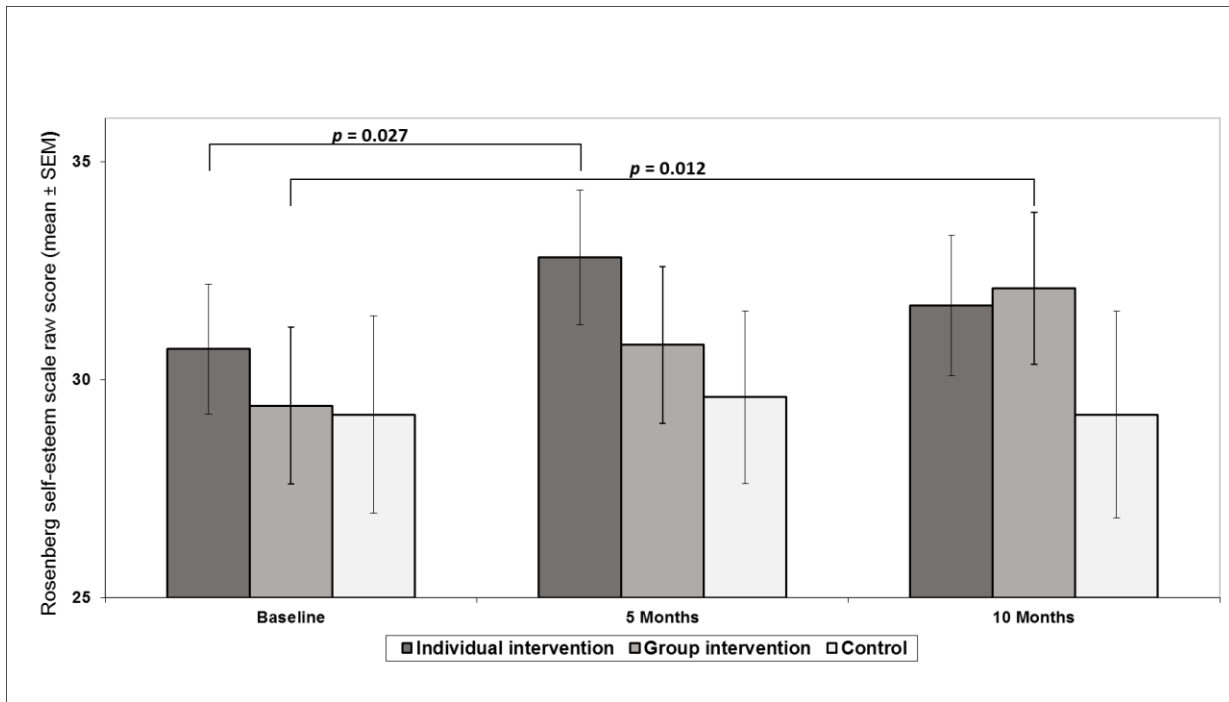


Figure 4. The changes in Rosenberg Self-Esteem Scale in individual and group-based neuropsychological interventions and wait-list controls in young adults with dyslexia. Measurement points are baseline (0 months), the end of intervention/wait-list control time (5 months) and the end of follow-up for the intervention groups/the end of intervention for wait-list control group (10 months). Based on post hoc analyses the change from baseline to 5 months was significant in individual intervention and the change from baseline to 10 months was significant in group intervention at the  $p < 0.05$  level.

Table 1. Comparisons between individual and group-based neuropsychological interventions and wait-list controls in self-report measures of psychological well-being of young adults with dyslexia. Measurement points are baseline (0 months), the end of intervention/wait-list control time (5 months) and the end of follow-up for the intervention groups/the end of intervention for wait-list control group (10 months).

Measures	Individual intervention			Group intervention			Wait-list control			p time	p group	p time x group int.ac. <sup>a</sup>
	0mos. n=39	5mos. n=38	10mos. n=38	0mos. n=36	5mos. n=36	10mos. n=35	0mos. n=39	5mos. n=39	10mos. n=33			
SAQ Success expectation	25.7 (4.2)	26.5 (4.1)	25.5 (4.3)	23.3 (5.5)	<b>25.2<sup>c</sup></b> (4.6)	<b>25.2<sup>d</sup></b> (5.0)	24.1 (4.7)	23.1 (5.4)	24.6 (5.5)	0.187	0.124	<b>0.005</b>
SAQ Social optimism	26.6 (4.1)	27.5 (3.8)	27.1 (4.2)	25.9 (4.8)	26.4 (5.2)	26.7 (5.4)	25.7 (4.9)	25.9 (5.0)	25.9 (5.6)	0.222	0.486	0.962
SAQ Social pessimism <sup>b</sup>	12.4 (4.5)	12.2 (5.2)	13.8 (5.3)	14.1 (5.7)	12.8 (5.4)	12.7 (5.3)	14.5 (4.5)	14.3 (5.2)	14.2 (5.4)	0.355	0.377	<b>0.052</b>
SAQ Task-avoidance <sup>b</sup>	17.2 (5.7)	15.7 (6.3)	<b>15.5<sup>d</sup></b> (6.8)	17.4 (6.5)	16.3 (6.5)	<b>14.7<sup>d</sup></b> (5.7)	16.5 (5.2)	17.4 (6.1)	16.7 (5.6)	<b>0.005</b>	0.855	0.076
POMS total score <sup>b</sup>	38.6 (16.7)	35.9 (17.0)	36.9 (19.1)	41.2 (16.8)	46.9 (22.5)	38.3 (19.6)	39.6 (19.3)	47.4 (21.8)	46.8 (25.3)	0.138	0.141	0.081
Rosenberg self-esteem	30.7 (4.6)	<b>32.8<sup>c</sup></b> (4.7)	31.7 (4.9)	29.4 (5.4)	30.8 (5.4)	<b>32.1<sup>d</sup></b> (5.0)	29.2 (7.0)	29.6 (6.1)	29.2 (6.6)	<b>0.009</b>	0.114	0.183

(Figures are mean raw scores (SD). Statistically significant figures are bolded. <sup>a</sup> Linear mixed model analyses <sup>b</sup> Less points equals a better result. <sup>c</sup> Statistically significant within-group change from 0 to 5 mos. and <sup>d</sup> from 0 to 10 mos. SAQ: Strategy Attribution questionnaire; POMS: Profile of Mood States, Finnish version of the POMS includes 38 questions; Rosenberg: Rosenberg self-esteem scale.)

Table 2. Comparisons between individual and group-based neuropsychological interventions and wait-list controls in quality of life (QOLIBRI-OS) in young adults with dyslexia. Measurement points are baseline (0 months), the end of intervention/wait-list control time (5 months) and the end of follow-up for the intervention groups/the end of intervention for wait-list control group (10 months).

QOLIBRI-OS	Individual intervention			Group intervention			Wait-list control			p time	p group	p time x group
	0mos. n=39	5mos. n=38	10mos. n=38	0mos. n=36	5mos. n=36	10mos. n=35	0mos. n=39	5mos. n=39	10mos. n=33			
Physical condition	2.41 (1.0)	2.58 (1.0)	2.58 (1.1)	2.31 (1.0)	2.33 (1.2)	2.71 (1.1)	2.49 (0.9)	2.46 (1.0)	2.24 (1.1)	0.479	0.847	0.119
Concentration & memory	2.08 (0.9)	<b>2.58<sup>b</sup></b> (0.9)	2.29 (1.0)	1.75 (1.1)	2.14 (1.0)	<b>2.26<sup>c</sup></b> (0.9)	1.95 (1.3)	1.74 (1.0)	2.06 (1.2)	<b>0.025</b>	0.084	<b>0.026</b>
Feelings and emotions	2.69 (0.9)	2.71 (0.8)	2.47 (0.9)	2.72 (1.0)	2.64 (1.0)	2.71 (1.0)	2.62 (1.2)	2.49 (1.1)	2.42 (1.2)	0.495	0.694	0.868
Day to day activities	3.28 (0.8)	3.11 (0.9)	3.16 (0.8)	2.89 (0.9)	3.08 (0.8)	3.09 (1.0)	3.03 (1.0)	2.85 (0.9)	2.88 (1.1)	0.835	0.306	0.426
Personal and social life	2.97 (1.0)	2.92 (1.0)	2.76 (1.0)	2.94 (1.1)	2.72 (1.1)	3.03 (1.1)	2.85 (1.0)	2.87 (1.0)	2.82 (1.0)	0.608	0.968	0.335
Current and future prospects	2.97 (0.9)	3.00 (0.9)	2.84 (1.1)	2.75 (1.1)	2.92 (1.1)	2.91 (1.1)	2.64 (0.9)	2.59 (1.0)	2.42 (1.1)	0.651	0.100	0.715
Total score	16.4 (3.7)	16.9 (3.3)	16.1 (4.1)	15.4 (4.0)	15.8 (4.4)	16.7 (4.3)	15.6 (4.2)	15.0 (4.2)	14.9 (5.2)	0.936	0.279	0.276

(Figures are mean raw scores (SD). Statistically significant figures are bolded. More points equals a better result. <sup>a</sup> Linear mixed model analyses.

<sup>b</sup>Statistically significant within-group change from 0 to 5 mos. and <sup>c</sup>from 0 to 10 mos. QOLIBRI-OS: The Quality of Life after Brain Injury Overall Scale.)

