

# Cognitive Reappraisal Reduces Academic Anxiety in University Students With Dyslexia

Holly Coates McDowall<sup>1</sup> , Kaili Rimfeld<sup>1,2</sup>, and Saloni Krishnan<sup>3</sup> 

**ABSTRACT**—University students with dyslexia have greater anxiety than their peers without dyslexia, especially related to their academic studies. Most universities focus on mitigating the learning needs of these students, for example, providing more time during exams. Relatively little attention is paid to the psychological impact of having dyslexia. In this preregistered study, we investigated whether cognitive reappraisal reduced academic anxiety in university students with dyslexia. We codesigned negative and neutral scenarios about academic life with university students with dyslexia. We presented university students (54 students with dyslexia and 51 neurotypical students) with these scenarios about academic life and asked them to rate their anxiety. As hypothesized, we observed that students with dyslexia had higher academic anxiety than those without dyslexia ( $d = 0.43$ ). When instructed to use cognitive reappraisal, all students, irrespective of having dyslexia or not, benefitted from an anxiety reduction ( $d = 0.87$ ). Our experimental research indicates cognitive reappraisal may be a valuable tool to support students. Furthermore, it may help those with dyslexia to manage the heightened emotional demands of academia. Intervention trials that assess the real-world implementation of cognitive reappraisal are now warranted.

The academic pressures of university, including high workloads, deadlines, exams, and assessments, are risk factors

<sup>1</sup>Department of Psychology, Royal Holloway, University of London, Surrey, England

<sup>2</sup>Social Genetic and Developmental Psychiatry Centre, Institute of Psychiatry, Psychology and Neuroscience, London, England

<sup>3</sup>UCL Division of Psychology and Language Sciences, London, England

Address correspondence to Holly Coates McDowall, Department of Psychology, Royal Holloway, University of London, Surrey, England; [holly.coatesmcdowall.2021@live.rhul.ac.uk](mailto:holly.coatesmcdowall.2021@live.rhul.ac.uk)

[Correction: This article first published on 17 December 2024; the layout has since been updated.]

associated with stress, anxiety, and depression among students (Mofatteh 2021). Tackling university with a specific learning difficulty such as dyslexia, which exacerbates these challenges, may require significantly more emotional resilience. Dyslexia is a learning difficulty characterized by problems with accurate or fluent word recognition, poor decoding, and poor spelling abilities (American Psychiatric Association 2013). According to the Higher Education Statistics Agency (2023), the prevalence of university students reporting dyslexia (and other specific learning difficulties) has been increasing from 0.45% in the late 90s to 4.6% to date. University students with dyslexia are less likely to pass modules or achieve good grades (Bergey, Deacon, and Parrila 2017; Richardson 2015). Students with dyslexia also face a heightened risk for increased emotional difficulties such as anxiety, depression, and low self-esteem (Arnold et al. 2005; Livingston, Siegel, and Ribary 2018; Vieira et al. 2024). Most dyslexia intervention research focuses on educational skills, for instance, targeting reading ability (Singleton 2009). Relatively little intervention focuses on mental health (Costantini, Ceschi, and Sartori 2020; Georgiou, Parrila, and McArthur 2024). Further, while universities typically provide academic mitigations for people with dyslexia, more emphasis could be placed on emotional support (Carroll and Iles 2006). In this study, we will focus on emotional regulation in people with dyslexia and assess whether a widely used cognitive behavioral therapy (CBT) strategy—cognitive reappraisal—could help students with dyslexia manage the emotional demands of university.

Recent systematic reviews suggest the two most common emotional difficulties faced by students with dyslexia are anxiety and low self-esteem (Francis et al. 2019; Livingston, Siegel, and Ribary 2018; McArthur et al. 2020; Vieira et al. 2024). However, there is some debate as to the specificity of these difficulties. Some studies have suggested that individuals with dyslexia experience generalized increases in anxiety and lower self-esteem (Ghisi et al. 2016; Ithour et al. 2021). Other studies indicate these increases

are specifically tied to completing academic tasks (Elgendi et al. 2021; McArthur et al. 2020; Novita 2016). Specific anxiety around education, as opposed to generalized anxiety which relates to everyday events or activities, can be referred to as academic anxiety, the feelings of apprehension or fear and excessive worry in relation to academic tasks such as assessments (Hooda and Saini 2017; Munir and Takov 2022). The evidence for increased academic anxiety in students with dyslexia is quite strong. Students with dyslexia show higher mathematics anxiety and test anxiety (Jordan, McGladdery, and Dyer 2014; Nelson, Lindstrom, and Foels 2015). Poor reading ability in students is associated with higher reading anxiety and lower academic achievement (Soares et al. 2023). Students with dyslexia were found to have higher academic anxiety (Carroll and Iles 2006; Elgendi et al. 2021) and also showed higher state anxiety levels prior to completing a reading task than those without dyslexia (Carroll and Iles 2006). In these studies, the effect sizes range from medium to large ( $\eta^2 = 0.05\text{--}0.5$ ). Understanding how to help students with dyslexia manage their academic anxiety could substantially improve their university experience.

Cognitive reappraisal is a highly effective emotional regulation strategy to reduce negative emotions (Gross 2015). It is a fundamental tool in CBT to elicit cognitive change and has been successful in interventions for anxiety (Clark 2022; Goldin et al. 2014). It refers to reframing the way one thinks about a situation to change the emotional impact of the situation (Gross 1998). For instance, in a recent study Nook and colleagues showed participants negative images and instructed them to think differently about the image to feel better. Cognitive reappraisal decreased people's negative affect; this was a large effect ( $d = 1.09$ ) (Nook et al. 2020). Participants instructed to use reappraisal reported less sadness after watching an emotional film clip (Troy et al. 2010). Cognitive reappraisal can also reduce social anxiety (Kivity and Huppert 2016), and it is associated with lower levels of anxiety and depression in experimental tasks (Bettis et al. 2019). Compared to strategies such as emotion suppression, cognitive reappraisal led to better interpersonal functioning and well-being (Gross and John 2003).

Emotional regulation has been relatively understudied in dyslexia (Wilmot et al. 2023). Contemporary interventions for *children* with dyslexia have focused on resolving emotional difficulties using CBT techniques (Boyes et al. 2021; Denton et al. 2021; Firth et al. 2013). Although these techniques have only been tested in small-scale studies, the evidence base is limited but promising. An intervention designed to change how school children think about their academic failures using CBT techniques improved reading ability; this was a medium effect ( $\eta^2 = 0.13$ ) (Chodkiewicz and Boyle 2016). In an experimental study, children with language disorder (many of whom will develop dyslexia) were

able to use reappraisal strategies when instructed to do so and could derive the same benefit as those without language disorder (Griffiths et al. 2021). Thus far, very little work has focused on teaching emotional regulation strategies such as reappraisal to adults with dyslexia. Interventions for adults are largely focused on enhancing reading ability and do not address secondary emotional consequences (Nukari et al. 2022). In a qualitative study, young adults with dyslexia emphasized the importance of having coping strategies (Claassens and Lessing 2015). There is a clear need to understand whether emotional regulation strategies could be an effective tool for students to cope with the emotional demands of academic studies at university.

In this study, we investigated whether cognitive reappraisal can reduce academic anxiety in university students with and without dyslexia. We also explored whether those with dyslexia experience differential benefit from cognitive reappraisal. We predicted that students with dyslexia might benefit more than neurotypical students from reappraisal because of the greater potential for change due to their higher academic anxiety. They may also benefit more because of the reduced use of emotional coping strategies in those with greater anxiety in academic subjects (Jordan, McGladdery, and Dyer 2014).

To assess whether cognitive reappraisal was effective, we adapted the design used by Nook et al. (2020) presenting challenging and neutral academic scenarios to students with and without dyslexia. These situations were codesigned with experts by experience (i.e., those with lived experience of dyslexia). Participants were asked to rate their anxiety in these different situations. They were given instructions on how to use cognitive reappraisal and asked to apply it to one set of negative scenarios. We then tested the following pre-registered hypotheses: (1) University students with dyslexia will experience higher academic anxiety than students without dyslexia when faced with challenging academic scenarios. (2) Using cognitive reappraisal will reduce academic anxiety in all participants. (3) University students with dyslexia will benefit more from cognitive reappraisal than students without dyslexia.

## METHODS

### Ethics

This study received approval by the central university ethics committee at Royal Holloway, University of London (ID: 3653). Participants were fully informed of their rights regarding the study, including their right to withdraw from the study at any point. Informed consent was obtained prior to participation.

## Participants

We recruited 105 undergraduate students (54 with dyslexia and 51 without) to take part in this study. The sample size was informed by a power analysis, see *Analysis*. The participants were British university students. The main recruiting university was Royal Holloway, University of London, where posters were displayed around campus and emails were distributed via heads of departments and the neurodiversity service. We also recruited participants from the recruitment service [www.prolific.ac](http://www.prolific.ac) as well as advertisements on social media. Participants received a £5 shopping voucher for participating.

Participants were 18–59 years old, with a mean age of 22.63 years ( $SD = 6.67$ ); 61% identified as female, 37% as male, and 2% as nonbinary. There were 13 mature students (over the age of 24) in the sample, all of whom reported having dyslexia. Most participants described their ethnicity as White British at 53%, 10% reported being Asian British or Asian, 3% reported being Black British, Caribbean, or African, 3% reported having multiple ethnicities, and 31% did not disclose their ethnicity. All participants were native English speakers with normal hearing and normal or corrected-to-normal vision.

To be included in the dyslexia group, participants had to report they had a diagnosis of dyslexia and also had to score above the cut-off on the Abbreviated Adult Reading History Questionnaire (ARHQ-Brief) (Feng et al. 2022); for more detail, see *Materials*. We excluded participants with diagnoses of autism, epilepsy, or a known genetic disorder such as Down syndrome. However, we did not exclude participants with other learning difficulties or attention deficit hyperactivity disorder (ADHD), as these commonly co-occur and excluding these participants would limit the generalizability of our findings (Chung, Patel, and Nizami 2020; Darweesh et al. 2020; Margari et al. 2013; Pauc 2005; Willcutt et al. 2007). In our dyslexia sample, thirteen participants reported having other specific learning difficulties (e.g., dyspraxia, dyscalculia, dysgraphia) and seven reported they had ADHD. Additionally, we did not screen or exclude participants with mental health difficulties such as severe depression and anxiety as again, and these commonly co-occur in individuals with dyslexia (Dahle, Knivsberg, and Andreassen 2011; Darweesh et al. 2020; Mugnaini et al. 2009; Nelson and Gregg 2012).

## Materials

The entirety of this experiment (screening measures, experimental task, and post-task questionnaires) was completed online on the experimental platform [www.gorilla.sc](http://www.gorilla.sc).

### Experimental Task Design

Our experimental task was adapted from an existing emotional regulation paradigm (Nook et al. 2020). Similar

methods measuring cognitive reappraisal have been found to be reasonably reliable in 18–21-year-olds, with an intra-class correlation of 0.59 over a 1-week timespan (Suksasilp et al. 2021).

At the start of the experiment, participants were given instructions in video format. Participants were told how to use cognitive reappraisal as an emotional regulation strategy, such as changing their interpretation of a situation to a more positive one. They were also given examples of cognitive reappraisal and shown the prompt for when to use it. The instructions on how to use cognitive reappraisal were adapted from Troy et al. (2010) and coproduced with students with dyslexia to ensure they were clear and understandable.

Participants then encountered 30 university scenarios and were asked to imagine each one was happening to them. Participants had the option to read or listen to the scenarios via an audio option. They encountered three conditions with ten scenarios each (see Figure 1 for an illustration). Ten scenarios were neutral, for example, “*You meet with friends before a lecture. One of them tells you about the sports charity ball and asks if you would like to go.*” The remaining 20 scenarios were designed to provoke anxiety (negative), for example, “*You are in an exam. You open the paper and read the essay question. It is ambiguous and you don’t know the meaning of one of the words.*” Half of the negative scenarios were assigned to the reappraisal condition, where participants were prompted to change their use of cognitive reappraisal before rating their anxiety. They were asked to rate how anxious they felt following each scenario on a Likert scale from 1 to 7 (1 = not at all anxious to 7 = extremely anxious). Our pilot data showed that this scale was sensitive to differences between the negative and neutral conditions (Appendix 1). The assignment of negative scenarios to the negative or the reappraisal conditions was counterbalanced across participants. Scenarios were presented in blocks of 5 (all from the same condition), and the order of the blocks was also counterbalanced to minimize bias. The trial order within each of the blocks was random.

The academic scenarios were codesigned with students with dyslexia, who are experts by experience. Scenarios were independently rated by 10 neurotypical university students (recruited from [prolific.ac](http://prolific.ac)) to verify negative scenarios did elicit anxiety (see Appendix 1). These ratings were used to assign the negative scenarios to two sets balanced in emotional impact.

### Standardized Tests and Other Questionnaires

*ARHQ-Brief*. The Abbreviated Adult Reading History Questionnaire (ARHQ-Brief) is a 6-item measure of reading history on a 5-point Likert scale (Feng et al. 2022). ARHQ-Brief overall scores are calculated by adding the total raw scores for the six items and dividing by the maximum

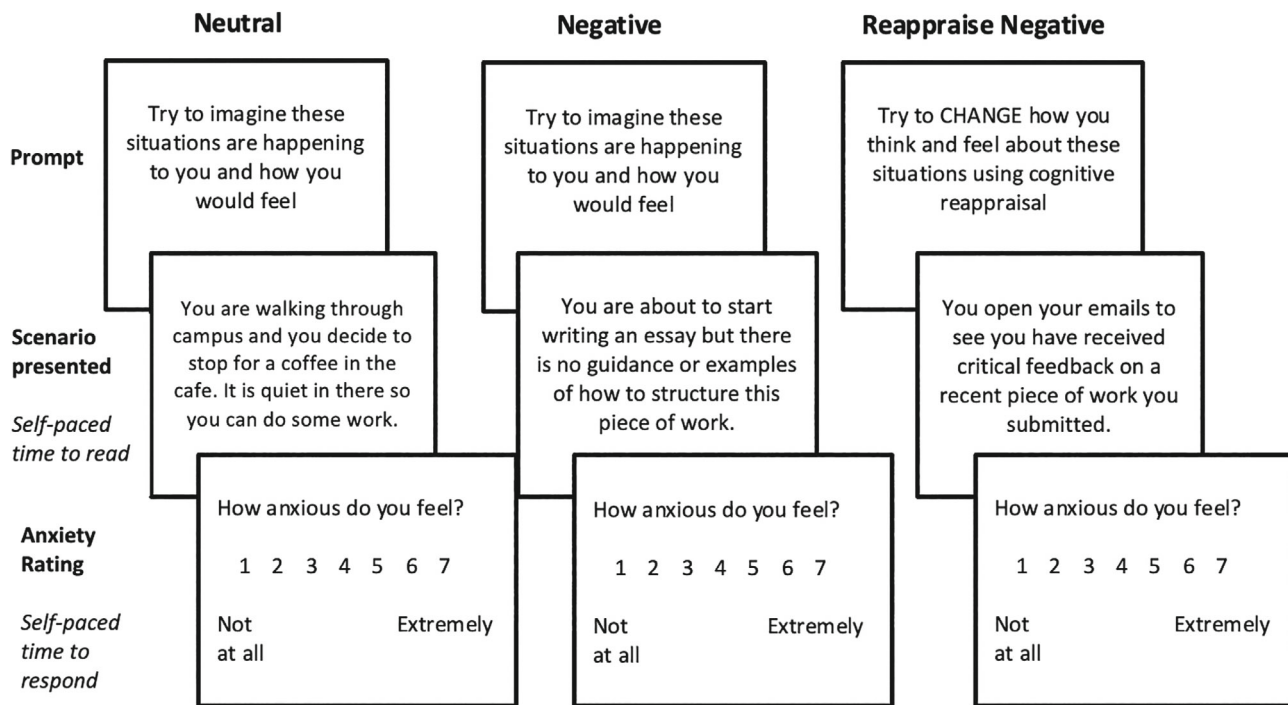


FIGURE 1. A visual depiction of 3 example trials, one from each condition.

possible score of 24. Higher scores suggest greater difficulties in reading. A cut-off score of 0.32 or over has been recommended, which indicates the person has a reading disability. The internal consistency of this measure is high, with a Cronbach's alpha of 0.85 (Feng et al. 2022).

**GAD-7.** The Generalized Anxiety Disorder scale (GAD-7) is a 7-item measure of generalized anxiety (Spitzer et al. 2006). The items measure the severity of anxiety symptoms over the past 2 weeks on a 4-point Likert scale from 0 (not at all) to 3 (nearly every day). The measure is widely used in clinical settings and in accordance with the DSM-5 criteria for generalized anxiety. Raw scores are used; higher scores indicate higher generalized anxiety. A cut-off score of 10 or greater corresponds to moderate-to-severe anxiety symptoms, indicating a clinically significant condition. The measure has a good construct and convergent validity among university students. The internal consistency of this measure is high, with a Cronbach's alpha of 0.85–0.93 (Byrd-Bredbenner, Eck, and Quick 2020).

**AAS.** The Academic Anxiety Scale (AAS) is an 11-item measure (Cassady 2020). The items measure academic anxiety on a 4-point Likert scale from 1 (not at all typical of me) to 4 (very typical of me). Raw scores are used; higher scores indicate higher anxiety. A cut-off score of 21–29 corresponds to moderate academic anxiety (Finch, Cassady, and Helsper 2024). This test has good reliability and validity with

a Cronbach's alpha of 0.90, indicating its effectiveness in assessing academic anxiety in university students (Cassady, Pierson, and Starling 2019).

**TOWRE.** Reading ability was measured using the Sight Word Efficiency and Phonemic Decoding Efficiency subtests from Test of Word Reading Efficiency (TOWRE; Torgesen, Rashotte, and Wagner 1999). This test has high internal consistency with average coefficients from 0.93 to 0.96; test–retest reliability coefficients range from 0.89 to 0.97 (Torgesen, Rashotte, and Wagner 1999). In the sight word efficiency subtest, participants read a list of words progressively increasing in decoding difficulty. In the phonemic decoding efficiency subtest, participants read a list of pseudowords that progressively increase in decoding difficulty. Participants are instructed to read aloud these lists as fast as they can, and their score is the number of words accurately read in 45 s. Higher scores, therefore, indicate greater reading proficiency.

This test is designed to be done face-to-face; however, we administered it online. Several researchers have indicated that standardized tests can be administered online (Daniel 2012; Hodge et al. 2019; Waite et al. 2006). As indicated in the manual, participants were given a practice trial. Due to the online presentation, it was not possible to give live feedback, although participants could listen to an example of their recordings to ensure their microphone was working. For the main list, recordings started as soon as the test list

was shown. For scoring, we measured the number of words correctly read in 45 s from the start of the recording, regardless of when participants began speaking.

*Use of Cognitive Reappraisal in Daily Life.* We also asked participants about their use of cognitive reappraisal strategies in their daily lives on two items. Firstly, “*When I am faced with a stressful situation, I make myself think about it in a way that helps me stay calm,*” which participants rated on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). Secondly, “*How often do you use cognitive reappraisal (changing the way you think about a situation) in your daily life?*”, which participants rated on a 4-point Likert scale from 1 (not at all) to 4 (all the time). Added together, participants could score a minimum of 2 and a maximum of 11. Higher scores indicated greater use of cognitive reappraisal.

### Procedure

The study was hosted on an online experimental platform ([www.gorilla.sc](http://www.gorilla.sc)). After informed consent, participants were asked to provide demographic details (age, gender, ethnicity, diagnoses, etc.) and complete the ARHQ-Brief. Eligibility was checked based on demographic data and ARHQ-Brief. If participants did not meet the eligibility criteria, they were immediately excluded and did not provide data. Participants then completed the main experimental task rating the different scenarios across three conditions (negative, negative with reappraisal, neutral). The specific scenarios in each condition were counterbalanced across participants. Following the experiment, participants then completed questionnaires to assess generalized anxiety (GAD-7), academic anxiety (AAS), and the two questions on their use of cognitive reappraisal. Finally, they completed the TOWRE sight word efficiency and phonemic decoding efficiency subtests. Participants were then debriefed.

### Analysis

For the experimental task, each participant’s average anxiety rating was computed in each condition. The average anxiety rating in the neutral condition gave us an individual’s baseline anxiety. An emotional reactivity score was computed by subtracting an individual’s baseline anxiety from the average of that individual’s anxiety ratings from the negative scenarios (without reappraisal). Cognitive reappraisal ability was calculated by subtracting the anxiety scores from the negative scenarios with cognitive reappraisal from the anxiety scores of the negative scenarios without cognitive reappraisal. A positive control was used as a functional

check on our dataset, following which we tested confirmatory hypotheses as listed in our preregistration:

[https://osf.io/7f86q/?view\\_only=0f3d9075ba89490086d6dd15c93f06f9](https://osf.io/7f86q/?view_only=0f3d9075ba89490086d6dd15c93f06f9).

Below we briefly summarize our preregistered analysis plan, including details of our power analysis for confirmatory hypothesis testing.

**Positive Control: Academic Anxiety Ratings Will Be Higher in the Negative Condition Relative to the Neutral Condition**  
If the experimental design is working as expected, the negative condition should elicit more anxiety than the neutral condition. We therefore planned to compare academic anxiety ratings in the negative and neutral conditions in all participants using a repeated measures *t*-test. To detect an effect size of  $d = 0.5$  (a medium effect), with an alpha level of 0.05 with 80% power, we needed a sample size of 34. Our planned sample size of 102 was greater than this.

**Hypothesis 1: University Students With Dyslexia Will Experience Higher Academic Anxiety Than Students Without Dyslexia When Faced With Challenging Academic Scenarios**

We planned to use an independent *t*-test to compare emotional reactivity scores between the groups. While there are no similar experimental measures, mental health differences in dyslexia usually show medium-large effects (Carroll and Iles 2006; Ghisi et al. 2016; Jordan, McGladdery, and Dyer 2014). Given our focus on anxiety in academic situations, we expected to observe a medium-large effect. A total sample size of 102 (51 participants in each group) was necessary to detect a medium effect size of  $d = 0.5$ , with an alpha level of 0.05 with 80% power.

**Hypothesis 2: Using Cognitive Reappraisal Strategy Will Reduce Academic Anxiety in all Participants**

To measure the effect of cognitive reappraisal in all participants, we planned to use a repeated measures *t*-test comparing scores in the negative only and the negative reappraisal conditions. To have 80% power to detect an effect size of  $d = 0.5$ , with an alpha level of 0.05, we again needed a sample size of 34. Our sample size of 105 was greater than this.

**Hypothesis 3: University Students With Dyslexia Will Benefit More From Cognitive Reappraisal Than Students Without Dyslexia**

To assess whether cognitive reappraisal ability differed by group, we planned to conduct an independent samples *t*-test

on the cognitive reappraisal ability scores. For 80% power to detect an effect size of  $d = 0.5$ , with an alpha level of 0.05, we needed a sample size of 102, or 51 per group. Our sample size of 105 met this criterion.

## RESULTS

Demographic details for all measures and experimental data are presented in Table 1.

### Positive Control

We found strong evidence in support of our positive control. We observed a significant main effect of condition on anxiety,  $t(104) = 26.79$ ,  $p < 0.001$ ,  $d = 2.6$ , with all participants reporting higher anxiety in the negative condition ( $M = 4.59$ ,  $SD = 1.11$ ) relative to the neutral condition ( $M = 1.81$ ,  $SD = 0.83$ ). Figure 2 illustrates anxiety by group and condition.

### Hypothesis 1: University Students With Dyslexia Will Experience Higher Academic Anxiety Than Students Without Dyslexia When Faced With Challenging Academic Scenarios

Students with dyslexia showed significantly higher emotional reactivity scores ( $M = 3.01$ ,  $SD = 1.07$ ) than those without dyslexia ( $M = 2.55$ ,  $SD = 1.02$ ),  $t(103) = 2.23$ ,  $p = 0.028$ ,  $d = 0.43$ . This is a significant group  $\times$  condition interaction,  $F(1, 103) = 4.949$ ,  $p = 0.028$ ,  $\eta_p^2 = 0.014$ . Students with dyslexia found the negative conditions ( $M = 4.9$ ,  $SD = 1.04$ ) evoked much more anxiety than the neutral

condition ( $M = 1.89$ ,  $SD = 0.78$ ). This difference was slightly attenuated in the students without dyslexia (negative:  $M = 4.27$ ,  $SD = 1.09$ ; neutral:  $M = 1.72$ ,  $SD = 0.87$ ).

### Hypothesis 2: Using Cognitive Reappraisal Strategy Will Reduce Academic Anxiety in all Participants

Using cognitive reappraisal significantly lowered anxiety for all participants,  $t(104) = 8.93$ ,  $p < 0.001$ ,  $d = 0.87$ . Participants had higher anxiety when they did not use reappraisal ( $M = 4.59$ ,  $SD = 1.11$ ) relative to when they did ( $M = 3.79$ ,  $SD = 0.97$ ).

### Hypothesis 3: University Students With Dyslexia Will Benefit More From Cognitive Reappraisal Than Students Without Dyslexia

Students with dyslexia did not benefit more from reappraisal ( $M = 0.81$ ,  $SD = 0.95$ ) than those without dyslexia ( $M = 0.79$ ,  $SD = 0.89$ ),  $t(102.98) = 0.11$ ,  $p = 0.92$ ,  $d = 0.02$ . This demonstrates a nonsignificant interaction for the groups on the negative and negative with reappraisal conditions,  $F(1, 103) = 0.011$ ,  $p = 0.92$ ,  $\eta_p^2 = 0.00002$ . Students with dyslexia found the negative cognitive reappraisal condition ( $M = 4.09$ ,  $SD = 0.85$ ) evoked less anxiety than the negative condition ( $M = 4.9$ ,  $SD = 1.04$ ). This difference was similar in the students without dyslexia (negative cognitive reappraisal:  $M = 3.48$ ,  $SD = 0.99$ ; negative:  $M = 4.27$ ,  $SD = 1.09$ ). A Bayesian  $t$ -test indicated moderate evidence in favor of the null hypothesis,  $BF_{10} = 0.207$ .

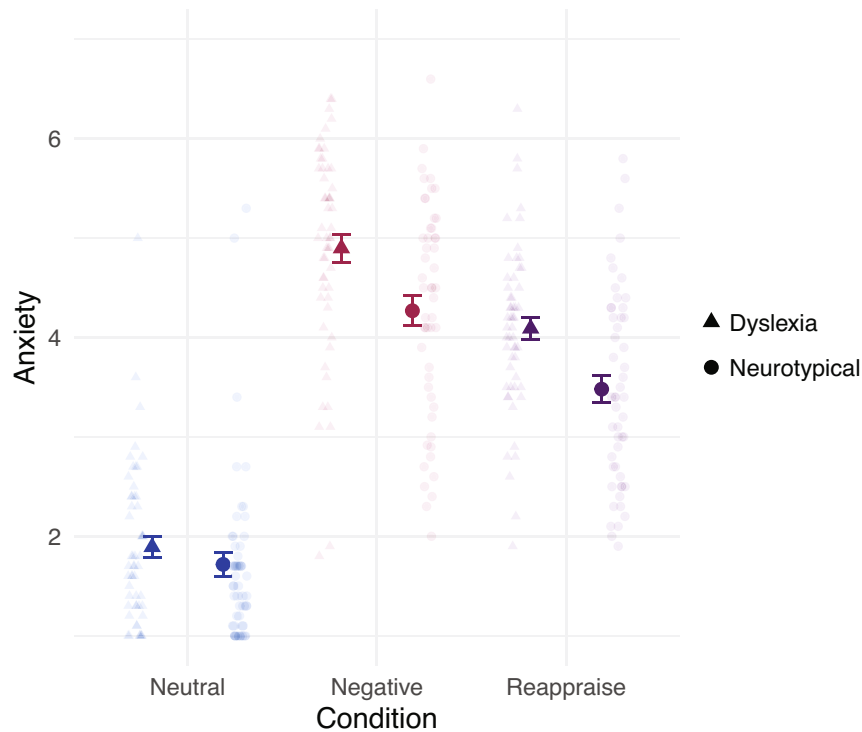
Given the age differences in our two groups, we also reanalyzed our data without the mature students. Removing

TABLE 1

Demographic details and test scores in each group (only raw scores are shown for the TOWRE). Means are shown with standard deviations in brackets.

	Dyslexia	Neurotypical	Statistical comparison
Experimental data			
Condition			
Neutral	1.89 (0.78)	1.72 (0.87)	1.09, $p = 0.281$
Negative	4.9 (1.04)	4.27 (1.09)	3.03, $p = 0.003$
Negative cognitive reappraisal	4.09 (0.85)	3.48 (0.99)	3.40, $p < 0.001$
Index			
Emotional reactivity	3.01 (1.07)	2.55 (1.02)	2.23, $p = 0.028$
Cognitive reappraisal ability	0.81 (0.95)	0.79 (0.89)	0.11, $p = 0.92$
Anxiety questionnaires			
GAD	9.81 (5.37)	8.18 (5.44)	1.55, $p = 0.124$
ASS	28.7 (6.85)	24.06 (8.31)	3.08, $p = 0.003$
Everyday use of cognitive reappraisal	6.48 (2.02)	6.75 (1.96)	0.68, $p = 0.499$
TOWRE reading tests			
Sight word efficiency	39.56 (10.65)	55.04 (8.02)	8.12, $p < 0.001$
Phonemic decoding efficiency	28.68 (8.14)	40.92 (6.61)	8.2, $p < 0.001$

Note: GAD is rated on a scale from 0 to 21; AAS is on a scale of 11 to 44; cognitive reappraisal is on a scale from 2 to 11; TOWRE raw scores were used; and for the dyslexia group  $N = 50$ . For the neurotypical group, we report phonemic decoding scores in  $N = 49$ , and sight word efficiency  $N = 47$ .



**FIGURE 2.** Anxiety ratings (shown on the y-axis) across conditions (blue—neutral, red—negative, and purple—reappraisal) in neurotypical students and students with dyslexia. The figure shows ratings in the three conditions on a scale of 1–7. Means for groups (triangle—dyslexia, circle—neurotypical) are depicted  $\pm$  1 standard error. The dots show individual data points in each condition.

the mature students from the data set did not change the findings (Appendix 2).

### Exploratory Analyses

As the following analyses are exploratory, we did not correct for multiple comparisons.

#### Generalized Versus Academic Anxiety

We compared general and academic specific anxiety in the same individuals to evaluate whether group differences were generalized or mainly reflected academic anxiety (see Table 1). Participants with dyslexia did not show significantly higher generalized anxiety scores than participants without dyslexia,  $t(102.5) = 1.55$ ,  $p = 0.124$ ,  $d = 0.30$ . A Bayesian  $t$ -test indicated anecdotal evidence in favor of the null hypothesis,  $BF_{10} = 0.602$ . In contrast, when examining academic anxiety as assessed by AAS, participants with dyslexia did show higher anxiety than students without dyslexia,  $t(93.34) = 3.08$ ,  $p = 0.003$ ,  $d = 0.61$ . The correlation between GAD-7 and AAS was significant,  $r = 0.63$ ,  $p < 0.001$ .

#### Use of Cognitive Reappraisal in Daily Life

We compared the use of cognitive reappraisal strategies in participants daily lives to measure if there was a difference

between the groups (see Table 1). Students with dyslexia did not report differential use of cognitive reappraisal in daily life relative to students without dyslexia,  $t(103) = 0.68$ ,  $p = 0.499$ ,  $d = 0.13$ . A Bayesian  $t$ -test indicated moderate evidence in favor of the null hypothesis,  $BF_{10} = 0.234$ .

#### The Relationship Between Reading Skills and Emotional Reactivity

Subtypes of dyslexia are often not reported or captured in diagnoses (McArthur et al. 2020); however, specific differences in reading skills could influence the associations between dyslexia and emotional difficulties (Francis et al. 2019). Here, we asked whether phonemic decoding and sight word efficiency skills differentially correlated with emotional reactivity, using a trait-based approach to maximize power. We chose to use raw scores + age in our analyses as in our sample, standardized scores were lower than usual in both groups, perhaps due to the online presentation of this test. We suspect cues of when to start reading may not have been as clear online as in a live presentation and participants may have started the task with a slight delay. Additionally, standardized scores go up to 24-years and 11 months old, and our sample contained participants over this age.

When examining raw TOWRE scores, as expected, the dyslexia group had lower reading efficiency scores than the group without dyslexia (Table 1). There was a significant difference between the groups on sight word reading efficiency,  $t(90.78) = 8.12$ ,  $p < 0.001$ ,  $d = 1.64$ , and phonemic decoding efficiency,  $t(97) = 8.2$ ,  $p < 0.001$ ,  $d = 1.65$ . A multiple regression analysis was conducted to assess the relative contribution of phonemic decoding and sight word efficiency on emotional reactivity scores, while controlling for age due to the large age range of the sample. This model was significant,  $F(3, 93) = 4.22$ ,  $p = 0.008$ , accounting for 9% of variance ( $R^2 = 0.12$ ,  $\text{adj-}R^2 = 0.091$ ). The partial regression coefficients showed that only phonemic decoding had a significant unique negative relationship to emotional reactivity after controlling for age and sight word efficiency ( $B = -0.05$ ,  $\beta = -0.43$ ,  $t(94) = 2.86$ ,  $p = 0.005$ ). In other words, those with poorer phonemic decoding ability showed higher levels of emotional reactivity. Sight word reading efficiency was not independently associated with emotional reactivity ( $B = 0.01$ ,  $\beta = 0.13$ ,  $t(94) = 0.86$ ,  $p = 0.39$ ), neither was age ( $B = -0.02$ ,  $\beta = -0.13$ ,  $t(94) = 1.33$ ,  $p = 0.187$ ).

## DISCUSSION

The aim of our study was to explore whether an emotional regulation strategy—cognitive reappraisal—could reduce academic anxiety in university students with dyslexia. As we predicted, students with dyslexia experienced higher academic anxiety than students without dyslexia. The use of a cognitive reappraisal strategy reduced academic anxiety in all participants, suggesting the helpfulness of incorporating this strategy. However, contrary to our expectations students with dyslexia did not derive greater benefit from cognitive reappraisal than students without dyslexia. Below we briefly discuss and contextualize the relevance of our two sets of findings.

### Cognitive Reappraisal in Dyslexia

Despite reports of heightened anxiety methods to regulate emotions have not been comprehensively explored in the context of dyslexia (Wilmot et al. 2023). This prompted our study's focus on cognitive reappraisal in dyslexia. We found cognitive reappraisal was an effective emotional regulation strategy for reducing academic anxiety in all students (not just dyslexic students). Cognitive reappraisal is a core technique in CBT treatments for depression (Beck 1983; Wang, He, and Feng 2022); however, less research has focused on its place in the treatment of anxiety. Some studies have found cognitive reappraisal is an effective intervention for social anxiety (Goldin et al. 2014; Kivity and Huppert 2016). Betts and colleagues showed the use of cognitive reappraisal

was associated with lower levels of anxiety in the lab (Betts et al. 2019). Unlike CBT intervention approaches, our study probed whether these strategies were effective using an experimental paradigm where we prompted people to use cognitive reappraisal. An original feature of our cognitive reappraisal paradigm was having realistic academic scenarios codesigned by people with lived experience. The use of cognitive reappraisal alleviated anxiety in these real-world scenarios.

We also assessed whether students with dyslexia benefited more from cognitive reappraisal than their peers. Given that academic anxiety is higher in students with dyslexia, and those with greater anxiety in academic domains are less likely to use positive reinterpretation strategies (Jordan, McGladery, and Dyer 2014), we predicted that teaching students' cognitive reappraisal would have a greater effect on those with dyslexia. However, we did not find evidence to support this; instead, we saw that both groups of students benefitted similarly from using cognitive reappraisal. One interpretation could be that cognitive reappraisal is no more effective the more anxious a person is and only brings a certain degree of emotional relief. Another possibility is that individuals with dyslexia who pursue higher education may have stronger protective strategies (Ghisi et al. 2016). In this vein, they may already employ cognitive reappraisal strategies in their regular life and, therefore, derive less benefit from being asked to use them. However, both groups of students reported using cognitive reappraisal to the same extent in their everyday lives.

Our findings show that students with dyslexia can use cognitive reappraisal when prompted to do so, and it is effective in reducing anxiety. We feel this is a promising step suggesting that cognitive reappraisal should be further explored as an anxiety reduction technique (Shore et al. 2017; Wang, He, and Feng 2022). However, our current study has several limitations that should be assessed in future work. Despite careful counterbalancing, there is a possible influence of demand characteristics on our data. As participants were directed to change their thoughts and feelings in the cognitive reappraisal condition, this may have biased them toward giving lower anxiety ratings. Incorporating an alternative emotional regulation strategy, such as acceptance or suppression (Szasz, Szentagotai, and Hofmann 2011; Troy et al. 2018), could serve as an active control for cognitive reappraisal. Additionally, it is possible those who chose to participate were the most likely to seek out strategies to reduce their anxiety. Our experimental methodology also limits the direct measurement of individuals' spontaneous tendency to employ and sustain cognitive reappraisal strategies (Wang, He, and Feng 2022). To assess generalizability to real-world settings, we need intervention trials that include cognitive reappraisal strategies over a more extended period.



### Heightened Anxiety in Dyslexia

In our study, we also observed that students with dyslexia experienced heightened academic anxiety. This is consistent with previous studies, which have shown academic anxiety is higher in university students with dyslexia (Carroll and Iles 2006; Elgendi et al. 2021). However, most of these studies have used self-report questionnaires (Francis et al. 2019). Our study was the first to use experimental methods to measure states of academic anxiety and cognitive reappraisal ability in people with dyslexia. To elicit an emotional response, we provided students with examples of realistic scenarios at university (meeting deadlines, taking exams, writing essays, failing assignments, and long reading lists), which were codesigned by people with lived experience.

In our study, as expected, students with dyslexia showed higher emotional reactivity scores than the nondyslexic students, indicating that the negative scenarios elicited greater anxiety for those with a history of reading difficulties. Critically, the neutral scenarios were not associated with the same rise in anxiety. As academic challenges are an inevitable part of university, this increased anxiety could considerably impact their overall university experience. Furthermore, these students may find themselves at a greater risk of poor academic performance as a consequence of academic anxiety (Mirawdali, Morrissey, and Ball 2018). However, some levels of academic anxiety can also drive academic performance (Ferdinand, Malanchini, and Rimfeld 2024). Future work to examine links between academic anxiety and academic attainment in dyslexic students is necessary. Our results suggest a need to build awareness about the emotional challenges faced by dyslexic students at university. The nature of these scenarios also provides insight into the types of tasks that students with dyslexia consider challenging—it is noteworthy that many of these are not strictly about reading. University students may have developed strategies to cope with their reading difficulties; instead, they may face greater pressure from the demands university life makes on organization, memory, or structuring essays (Mortimore and Crozier 2006; Rose 2009).

There is significant debate about the nature of anxiety in dyslexia and whether it is generalized or specific. In our study, in addition to our experimental measures, we used questionnaires to measure academic anxiety and general anxiety. In line with what we observed experimentally, students with dyslexia reported higher academic anxiety than students without dyslexia. Yet, differences between students with and without dyslexia on the measure of generalized anxiety were not significant (and our Bayesian analyses indicated anecdotal evidence for the null). Our findings are consistent with the idea that students with dyslexia have greater academic anxiety—but not necessarily general anxiety—than students without dyslexia (Elgendi et al. 2021; Nelson and Gregg 2012; Nelson, Lindstrom, and Foels 2015; Jordan,

McGladdery, and Dyer 2014; Soares et al. 2023). This is particularly critical as university services may be focused on the assessment and support of diagnosed anxiety disorders such as generalized anxiety (Elgendi et al. 2021; Royal College of Psychiatrists 2020).

There is some debate on how subtypes of dyslexia relate to emotional reactivity, but empirical data are limited (McArthur et al. 2020). Given we had both phonological decoding and sight word efficiency scores, we explored whether these subskills of reading differentially correlated with emotional reactivity. We found that phonemic decoding emerged as the only significant unique contributor in explaining academic anxiety over and above variance accounted for by age and sight word. At face value, this supports the theory that there are subtypes of dyslexia that could influence the association between mental health difficulties and dyslexia (Francis et al. 2019). Phonological processing is considered the core deficit in dyslexia (Hulme and Snowling 2009), and difficulties in this domain may be the key driver of difficulties in reading speed. However, it may simply be that phonemic decoding was the hardest task for all participants and, therefore, was related to academic anxiety.

It is also worth noting that we did not exclude participants with other specific learning difficulties, ADHD, or social anxiety due to the common nature of these comorbidities found in dyslexia (Carroll and Iles 2006; Nelson and Gregg 2012). Comorbidities such as ADHD have been shown to increase the risk of anxiety in individuals with dyslexia (McArthur et al. 2024). In our sample, eighteen participants suspected they had other conditions in addition to dyslexia such as ADHD or other specific learning difficulties. While these were not sufficient numbers to conduct separate analyses, those with additional diagnoses had similar emotional reactivity scores to those without.

### Recommendations for University Services

Students with dyslexia have reported that university does not offer adequate emotional support (Carroll and Iles 2006). Universities mainly provide academic adjustments and support for individuals studying with dyslexia, including tutoring and extra time during exams. However, our findings suggest that the academic demands of university provoke particular anxiety in dyslexic students. We recommend universities raise awareness about these emotional needs in students with dyslexia to promote self-advocacy, as well as in the staff that support students with dyslexia (e.g., neurodiversity services, personal tutors). We also recommend that they periodically screen for academic anxiety.

Specific support to reduce anxiety should also be incorporated into support packages for students with dyslexia. For example, university's mental health advisors could offer targeted drop-in sessions for students with dyslexia.

Universities could run psychoeducation programs to help students learn about the impact that anxiety has on academic performance and identify unhelpful behaviors such as procrastination (Hooda and Saini 2017). A cost-effective solution would be providing students with resources such as guided self-help materials. These could highlight effective cognitive strategies to manage anxiety. Teaching students such cognitive techniques—and encouraging them to practice using them over time—could lower anxiety. This would allow students to challenge their negative evaluations of their academic performance and construct more rational, positive interpretations, which will increase their well-being (Francis et al. 2019; Jordan, McGladdery, and Dyer 2014). Our results suggest that one such strategy could be cognitive reappraisal. Another tool could include cohort or group sessions to facilitate sharing of experiences and tools that work (Nukari et al. 2022).

### Conclusions

In summary, this study examined the efficacy of cognitive reappraisal—an emotional regulation strategy—for reducing academic anxiety in university students with dyslexia. As expected, students with dyslexia were found to have higher levels of academic anxiety compared to their peers. Cognitive reappraisal was found to reduce academic anxiety in both students with and without dyslexia. Both groups benefited from the strategy. The results are promising, suggesting that cognitive reappraisal can be a valuable tool for alleviating academic anxiety for students with dyslexia. Future research is needed to incorporate cognitive reappraisal in interventions designed to support students with dyslexia. By supporting students with dyslexia in managing their academic anxiety, we not only enhance their educational experience but also equip them with essential tools to tackle challenging academic situations throughout their lives.

**ACKNOWLEDGMENTS**—Royal Holloway provides a sum of £250 for Doctoral Clinical Psychology research projects. No further funding is required for this project.

### ETHICS STATEMENT

This study has received approval by the central university ethics committee at Royal Holloway, University of London (ID: 3653).

### CONSENT

Participants were fully informed of their rights regarding the study, including their right to withdraw from the study at any point.

### CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

### DATA AVAILABILITY STATEMENT

All anonymized data will be made available on OSF.

### REFERENCES

- American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders*. (5th ed.). Washington, DC: American Psychological Association. <https://doi.org/10.1176/appi.books.9780890425596>
- Arnold, E. M., Goldston, D. B., Walsh, A. K., et al. (2005). Severity of Emotional and Behavioral Problems Among Poor and Typical Readers. *Journal of Abnormal Child Psychology*, 33(2), 205–217. <https://doi.org/10.1007/s10802-005-1828-9>
- Beck, A. T. (1983). Cognitive Therapy of Depression: New Perspectives. In P. J. Clayton, & J. E. Barrett (Eds.), *Treatment of Depression: Old Controversies and New Approaches*. (pp. 265–290). New York: Raven Press.
- Bergey, B. W., Deacon, S. H., & Parrila, R. K. (2017). Metacognitive Reading and Study Strategies and Academic Achievement of University Students With and Without a History of Reading Difficulties. *Journal of Learning Disabilities*, 50(1), 81–94. <https://doi.org/10.1177/0022219415597020>
- Bettis, A. H., Henry, L., Prussien, K. V., et al. (2019). Laboratory and Self-Report Methods to Assess Reappraisal and Distraction in Youth. *Journal of Clinical Child and Adolescent Psychology*, 48(6), 855–865. <https://doi.org/10.1080/15374416.2018.1466306>
- Boyes, M. E., Leitão, S., Claessen, M., Dzidic, P., Badcock, N. A., & Nayton, M. (2021). Piloting ‘Clever Kids’: A Randomised-Controlled Trial Assessing Feasibility, Efficacy, and Acceptability of a Socioemotional Well-Being Programme for Children With Dyslexia. *British Journal of Educational Psychology*, 91(3), 950–971. <https://doi.org/10.1111/bjep.12401>
- Byrd-Bredbenner, C., Eck, K., & Quick, V. (2020). Psychometric Properties of the Generalised Anxiety Disorder-7 and Generalised Anxiety Disorder-Mini in United States University Students. *Frontiers in Psychology*, 11, 550533. <https://doi.org/10.3389/fpsyg.2020.550533>
- Carroll, J. M., & Iles, J. E. (2006). An Assessment of Anxiety Levels in Dyslexic Students in Higher Education. *British Journal of Educational Psychology*, 76(3), 651–662. <https://doi.org/10.1348/000709905X66233>
- Cassady, J. C. (2020). Academic Anxiety Scale. *Academic Anxiety Resource Center*. <https://sites.bsu.edu/aarc/research/academic-anxiety-scale/>
- Cassady, J. C., Pierson, E. E., & Starling, J. M. (2019). Predicting Student Depression With Measures of General and Academic Anxieties. *Frontiers in Education (Lausanne)*, 4, 11. <https://doi.org/10.3389/feduc.2019.00011>
- Chodkiewicz, A. R., & Boyle, C. (2016). Promoting Positive Learning in Australian Students Aged 10- To 12-Years-Old Using Attribution Retraining and Cognitive Behavioral Therapy: A

- Pilot Study. *School Psychology International*, 37(5), 519–535. <https://doi.org/10.1177/0143034316667114>
- Chung, P. J., Patel, D. R., & Nizami, I. (2020). Disorder of Written Expression and Dysgraphia: Definition, Diagnosis, and Management. *Translational Pediatrics*, 9, 46–54. <https://doi.org/10.21037/tp.2019.11.01>
- Classens, T., & Lessing, A. C. (2015). Young Adult Learners With Dyslexia: Their Socio-Emotional Support Needs During Adolescence. *Journal of Psychology in Africa*, 25(1), 32–36. <https://doi.org/10.1080/14330237.2015.1007599>
- Clark, D. A. (2022). Cognitive reappraisal. *Cognitive and Behavioral Practice*, 29(3), 564–566. <https://doi.org/10.1016/j.cbpra.2022.02.018>
- Costantini, A., Ceschi, A., & Sartori, R. (2020). Psychosocial Interventions for the Enhancement of Psychological Resources Among Dyslexic Adults: A Systematic Review. *Sustainability*, 12(19), 7994. <https://doi.org/10.3390/su12197994>
- Dahle, A. E., Knivsberg, A., & Andreassen, A. B. (2011). Coexisting Problem Behaviour in Severe Dyslexia. *Journal of Research in Special Educational Needs*, 11(3), 162–170. <https://doi.org/10.1111/j.1471-3802.2010.01190.x>
- Daniel, M. H. (2012). *Equivalence of Q-Interactive Administered Cognitive Tasks: WISC-IV (Q-Interactive Technical Report 2)*. Bloomington, MN: Pearson.
- Darweesh, A. M., Elserogy, Y. M., Khalifa, H., Gabra, R. H., & El-Ghafour, M. A. (2020). Psychiatric Comorbidity Among Children and Adolescents With Dyslexia. *Middle East Current Psychiatry*, 27, 28. <https://doi.org/10.1186/s43045-020-00035-y>
- Denton, C. A., Montroy, J. J., Zucker, T. A., & Cannon, G. (2021). Designing an Intervention in Reading and Self-Regulation for Students With Significant Reading Difficulties, Including Dyslexia. *Learning Disability Quarterly*, 44(3), 170–182. <https://doi.org/10.1177/0731948719899479>
- Elgendi, M. M., Stewart, S. H., MacKay, E. J., & Deacon, S. H. (2021). Two Aspects of Psychological Functioning in Undergraduates With a History of Reading Difficulties: Anxiety and Self-Efficacy. *Annals of Dyslexia*, 71, 84–102. <https://doi.org/10.1007/s11881-021-00223-3>
- Feng, L., Hancock, R., Watson, C., et al. (2022). Development of an Abbreviated Adult Reading History Questionnaire (ARHQ-Brief) Using a Machine Learning Approach. *Journal of Learning Disabilities*, 55(5), 427–442. <https://doi.org/10.1177/00222194211047631>
- Ferdinand, R., M. Malanchini, and K. Rimfeld. 2024. Maths Motivation Predicts STEM Career Choice in Young Adults Better Than Maths Anxiety. <https://doi.org/10.31234/osf.io/ntx25>.
- Finch, W. H., Cassady, J. C., & Helsper, C. A. (2024). Identification and Validation of Severity Standards for the Academic Anxiety Scale. *International Journal of Testing*, 24(2), 145–168. <https://doi.org/10.1080/15305058.2024.2317758>
- Firth, N., Frydenberg, E., Steeg, C., & Bond, L. (2013). Coping Successfully With Dyslexia: An Initial Study of an Inclusive School-Based Resilience Programme. *Dyslexia*, 19(2), 113–130. <https://doi.org/10.1002/dys.1453>
- Francis, D. A., Caruana, N., Hudson, J. L., & McArthur, G. M. (2019). The Association Between Poor Reading and Internalising Problems: A Systematic Review and Meta-Analysis. *Clinical Psychology Review*, 67, 45–60. <https://doi.org/10.1016/j.cpr.2018.09.002>
- Georgiou, G. K., Parrila, R., & McArthur, G. (2024). Dyslexia and Mental Health Problems: Introduction to the Special Issue. *Annals of Dyslexia*, 74, 1–3. <https://doi.org/10.1007/s11881-024-00300-3>
- Ghisi, M., Bottesi, G., Re, A. M., Cerea, S., & Mammarella, I. C. (2016). Socioemotional Features and Resilience in Italian University Students With and Without Dyslexia. *Frontiers in Psychology*, 7, 478. <https://doi.org/10.3389/fpsyg.2016.00478>
- Goldin, P. R., Lee, I., Ziv, M., Jazaieri, H., Heimberg, R. G., & Gross, J. J. (2014). Trajectories of Change in Emotion Regulation and Social Anxiety During Cognitive-Behavioral Therapy for Social Anxiety Disorder. *Behaviour Research and Therapy*, 56(1), 7–15. <https://doi.org/10.1016/j.brat.2014.02.005>
- Griffiths, S., Suksasilp, C., Lucas, L., Sebastian, C. L., & Norbury, C. (2021). Relationship Between Early Language Competence and Cognitive Emotion Regulation in Adolescence. *Royal Society Open Science*, 8(10), 210742. <https://doi.org/10.1098/rsos.210742>
- Gross, J. J. (1998). Antecedent- and Response-Focused Emotion Regulation: Divergent Consequences for Experience, Expression, and Physiology. *Journal of Personality and Social Psychology*, 74(1), 224–237. <https://doi.org/10.1037/0022-3514.74.1.224>
- Gross, J. J. (2015). Emotion Regulation: Current Status and Future Prospects. *Psychological Inquiry*, 26(1), 1–26. <https://doi.org/10.1080/1047840X.2014.940781>
- Gross, J. J., & John, O. P. (2003). Individual Differences in Two Emotion Regulation Processes: Implications for Affect, Relationships, and Wellbeing. *Journal of Personality and Social Psychology*, 85(2), 348–362. <https://doi.org/10.1037/0022-3514.85.2.348>
- Higher Education Statistics Agency. 2023. Who's Studying in HE?: Personal Characteristics. <https://www.hesa.ac.uk/data-and-analysis/students/whos-in-he/characteristics>.
- Hodge, M. A., Sutherland, R., Jeng, K., et al. (2019). Literacy Assessment via Telepractice Is Comparable to Face-To-Face Assessment in Children With Reading Difficulties Living in Rural Australia. *Telemedicine and e-Health*, 25(4), 279–287. <https://doi.org/10.1089/tmj.2018.0049>
- Hooda, M., & Saini, A. (2017). Academic Anxiety: An Overview. *Educational Quest: An International Journal of Education and Applied Social Science*, 8(3), 807–810. <https://doi.org/10.5958/2230-7311.2017.00139.8>
- Hulme, C., & Snowling, M. J. (2009). *Developmental Disorders of Language Learning and Cognition*. Oxford, UK: John Wiley & Sons.
- Ihbour, S., Anarghou, H., Boulhana, A., Najimi, M., & Chigr, F. (2021). Mental Health Among Students With Neurodevelopmental Disorders: Case of Dyslexic Children and Adolescents. *Dementia & Neuropsychologia*, 15(4), 533–540. <https://doi.org/10.1590/1980-57642021dn15-040014>
- Jordan, J., McGladdery, G., & Dyer, K. (2014). Dyslexia in Higher Education: Implications for Maths Anxiety, Statistics Anxiety and Psychological Well-Being: Dyslexia, Maths Anxiety, Statistics Anxiety and Psychological Well-Being. *Dyslexia*, 20(3), 225–240. <https://doi.org/10.1002/dys.1478>
- Kivity, Y., & Huppert, J. D. (2016). Does Cognitive Reappraisal Reduce Anxiety? A Daily Diary Study of a Micro-Intervention

- With Individuals With High Social Anxiety. *Journal of Consulting and Clinical Psychology*, 84(3), 269–283. <https://doi.org/10.1037/ccp0000075>
- Livingston, E. M., Siegel, L. S., & Ribary, U. (2018). Developmental Dyslexia: Emotional Impact and Consequences. *Australian Journal of Learning Difficulties*, 23(2), 107–135. <https://doi.org/10.1080/19404158.2018.1479975>
- Margari, L., Buttiglione, M., Craig, F., et al. (2013). Neuropsychopathological Comorbidities in Learning Disorders. *BMC Neurology*, 13(1), 1–6. <https://doi.org/10.1186/1471-2377-13-198>
- McArthur, G., Doust, A., Banales, E., Robidoux, S., & Kohonen, S. (2024). Are Comorbidities of Poor Reading Related to Elevated Anxiety in Children? *Annals of Dyslexia*, 74(1), 47–65. <https://doi.org/10.1007/s11881-023-00292-6>
- McArthur, G. M., Filardi, N., Francis, D. A., Boyes, M. E., & Badcock, N. A. (2020). Self-Concept in Poor Readers: A Systematic Review and Meta-Analysis. *PeerJ*, 8(1–36), e8772. <https://doi.org/10.7717/peerj.8772>
- Mirawdali, S., Morrissey, H., & Ball, P. (2018). Academic Anxiety and Its Effects on Academic Performance. *International Journal of Current Research*, 10(6), 70017–70026. <http://hdl.handle.net/2436/621849>
- Mofatteh, M. (2021). Risk Factors Associated With Stress, Anxiety, and Depression Among University Undergraduate Students. *AIMS Public Health*, 8(1), 36–65. <https://doi.org/10.3934/publichealth.2021004>
- Mortimore, T., & Crozier, W. R. (2006). Dyslexia and Difficulties With Study Skills in Higher Education. *Studies in Higher Education*, 31(2), 235–251. <https://doi.org/10.1080/03075070600572173>
- Mugnaini, D., Lassi, S., La Malfa, G., & Albertini, G. (2009). Internalising Correlates of Dyslexia. *World Journal of Pediatrics*, 5, 255–264. <https://doi.org/10.1007/s12519-009-0049-7>
- Munir, S., & Takov, V. (2022). *Generalised Anxiety Disorder*. Treasure Island, FL: StatPearls Publishing.
- Nelson, J. M., & Gregg, N. (2012). Depression and Anxiety Among Transitioning Adolescents and College Students With ADHD, Dyslexia, or Comorbid ADHD/Dyslexia. *Journal of Attention Disorders*, 16(3), 244–254. <https://doi.org/10.1177/1087054710385783>
- Nelson, J. M., Lindstrom, W., & Foels, P. A. (2015). Test Anxiety Among College Students With Specific Reading Disability (Dyslexia): Nonverbal Ability and Working Memory as Predictors. *Journal of Learning Disabilities*, 48(4), 422–432. <https://doi.org/10.1177/0022219413507604>
- Nook, E. C., Vidal Bustamante, C. M., Cho, H. Y., & Somerville, L. H. (2020). Use of Linguistic Distancing and Cognitive Reappraisal Strategies During Emotion Regulation in Children, Adolescents, and Young Adults. *Emotion*, 20(4), 525–540. <https://doi.org/10.1037/emo0000570>
- Novita, S. (2016). Secondary Symptoms of Dyslexia: A Comparison of Self-Esteem and Anxiety Profiles of Children With and Without Dyslexia. *European Journal of Special Needs Education*, 31(2), 279–288. <https://doi.org/10.1080/08856257.2015.1125694>
- Nukari, J. M., Laasonen, M. R., Arkkila, E. P., Haapanen, M., Lipsanen, J. O., & Poutiainen, E. T. (2022). Neuropsychological Intervention of Dyslexia Has a Positive Effect on Aspects of Psychological Well-Being in Young Adults—A Randomised Controlled Study. *Dyslexia*, 28(2), 166–184. <https://doi.org/10.1002/dys.1697>
- Pauc, R. (2005). Comorbidity of Dyslexia, Dyspraxia, Attention Deficit Disorder (ADD), Attention Deficit Hyperactive Disorder (ADHD), Obsessive Compulsive Disorder (OCD) and Tourette's Syndrome in Children: A Prospective Epidemiological Study. *Clinical Chiropractic*, 8(4), 189–198. <https://doi.org/10.1016/j.clch.2005.09.007>
- Richardson, J. T. E. (2015). Academic Attainment in Students With Dyslexia in Distance Education. *Dyslexia*, 21(4), 323–337. <https://doi.org/10.1002/dys.1502>
- Rose, S. J. (2009). *Identifying and Teaching Children and Young People With Dyslexia and Literacy Difficulties: An Independent Report From Sir Jim Rose to the Secretary of State for Children, Schools and Families*. London, UK: Department for Children, Schools and Families.
- Royal College of Psychiatrists (RCPsych). (2020). Mental Health of Higher Education Students (CR231).
- Shore, T., Cohen Kadosh, K., Lommen, M., Cooper, M., & Lau, J. Y. (2017). Investigating the Effectiveness of Brief Cognitive Reappraisal Training to Reduce Fear in Adolescents. *Cognition and Emotion*, 31(4), 806–815. <https://doi.org/10.1080/02699931.2016.1159542>
- Singleton, C. (2009). *Intervention for Dyslexia. A Review of Published Evidence on the Impact of Specialist Dyslexia Teaching*. Hull, UK: University of Hull.
- Soares, S., Boyes, M. E., Parrila, R., & Badcock, N. A. (2023). Does Reading Anxiety Impact on Academic Achievement in Higher Education Students? *Dyslexia*, 29(3), 179–198. <https://doi.org/10.1002/dys.1738>
- Spitzer, R. L., Kroenke, K., Williams, J. B., & Löwe, B. (2006). A Brief Measure for Assessing Generalised Anxiety Disorder: The GAD-7. *Archives of Internal Medicine*, 166(10), 1092–1097. <https://doi.org/10.1001/archinte.166.10.1092>
- Suksasilp, C., Griffiths, S., Sebastian, C. L., & Norbury, C. (2021). Reliability and Validity of a Temporal Distancing Emotion Regulation Task in Adolescence. *Emotion*, 21(4), 830–841. <https://doi.org/10.1037/emo0000744>
- Szasz, P. L., Szentagotai, A., & Hofmann, S. G. (2011). The Effect of Emotion Regulation Strategies on Anger. *Behaviour Research and Therapy*, 49(2), 114–119. <https://doi.org/10.1016/j.brat.2010.11.011>
- Torgesen, J. K., Rashotte, C. A., & Wagner, R. K. (1999). *TOWRE: Test of Word Reading Efficiency*. Austin, TX: Pro-Ed.
- Troy, A. S., Shallcross, A. J., Brunner, A., Friedman, R., & Jones, M. C. (2018). Cognitive Reappraisal and Acceptance: Effects on Emotion, Physiology, and Perceived Cognitive Costs. *Emotion*, 18(1), 58–74. <https://doi.org/10.1037/emo0000371>
- Troy, A. S., Wilhelm, F. H., Shallcross, A. J., & Mauss, I. B. (2010). Seeing the Silver Lining: Cognitive Reappraisal Ability Moderates the Relationship Between Stress and Depressive Symptoms. *Emotion*, 10(6), 783–795. <https://doi.org/10.1037/a0020262>
- Vieira, A. P. A., Peng, P., Antoniuk, A., et al. (2024). Internalising Problems in Individuals With Reading, Mathematics and Unspecified Learning Difficulties: A Systematic Review and Meta-Analysis. *Annals of Dyslexia*, 74(1), 4–26. <https://doi.org/10.1007/s11881-023-00294-4>
- Waite, M. C., Cahill, L. M., Theodoras, D. G., Busuttin, S., & Russell, T. G. (2006). A Pilot Study of Online Assessment

of Childhood Speech Disorders. *Journal of Telemedicine and Telecare*, 12, 3\_suppl, 92–94. <https://doi.org/10.1258/135763306779380048>

Wang, X., He, Y., & Feng, Z. (2022). The Antidepressant Effect of Cognitive Reappraisal Training on Individuals Cognitively Vulnerable to Depression: Could Cognitive Bias Be Modified Through the Prefrontal–Amygdala Circuits? *Frontiers in Human Neuroscience*, 16, 919002. <https://doi.org/10.3389/fnhum.2022.919002>

Willcutt, E. G., Pennington, B. F., Olson, R. K., & DeFries, J. C. (2007). Understanding Comorbidity: A Twin Study of Reading Disability and Attention-Deficit/Hyperactivity Disorder. *American Journal of Medical Genetics. Part B*, 144B(6), 709–714. <https://doi.org/10.1002/ajmg.b.30310>

Wilmot, A., Hasking, P., Leitão, S., Hill, E., & Boyes, M. (2023). Understanding Mental Health in Developmental Dyslexia: A Scoping Review. *International Journal of Environmental Research and Public Health*, 20(2), 1653. <https://doi.org/10.3390/ijerph20021653>

## APPENDIX 1: PILOT DATA TO CHOOSE ACADEMIC SCENARIOS

### PARTICIPANTS

Ten undergraduate students (4 females and 6 males) were recruited through Prolific.ac (aged 19–21 years). These participants did not take part in the experimental study. They provided informed consent before completing the pilot experiment.

### METHODS

Participants were asked to read 30 academic scenarios (10 neutral and 20 negative) and encouraged to imagine each scenario was happening to them. They were asked to rate how anxious they felt after each scenario from 1 = not at all to 7 = extremely.

### RESULTS

The table below shows the anxiety ratings data for the chosen neutral and negative scenarios. These show significant differences  $t(28) = 11.88$ ,  $p < 0.001$ ,  $d = 6.36$  suggesting the scenarios are appropriate and are sensitive to differences. Importantly, are no floor or ceiling effects for the negative ratings Table A1.

TABLE A1

Mean ratings for scenarios.

Scenarios	N	Mean	SD
Neutral	10	1.56	0.29
Negative	20	4.55	0.76

TABLE A2

Descriptive statistics for the data with mature students removed. Means for each condition are shown, with 1 SD in brackets. Raw scores are provided for TOWRE measures.

	Dyslexia	Neurotypical
N	41	51
Age	21.14 (1.67)	20.16 (1.67)
TOWRE sight word efficiency	39.46 (10.78)	55.04 (8.02)
TOWRE phonemic decoding efficiency	27.95 (7.68)	40.92 (6.61)
Condition		
Neutral	1.84 (0.75)	1.72 (0.87)
Negative	4.94 (1.08)	4.27 (1.09)
Negative cognitive reappraisal	4.03 (0.81)	3.48 (0.99)
Index		
Emotional reactivity	3.1 (1.11)	2.55 (1.02)
Cognitive reappraisal ability	0.91 (0.98)	0.79 (0.89)

Note: For TOWRE; dyslexia group  $N = 39$ , neurotypical group; phonemic decoding scores  $N = 49$ , sight word and total  $N = 47$ .

## APPENDIX 2: RESULTS AFTER REMOVING MATURE STUDENTS

To ensure the large number of mature students did not affect the pattern of results, we repeated all analyses removing this group of older students. Table A2 shows the demographic details and scores obtained by the dyslexic group.

### Positive Control

As before, we found strong evidence in support of our positive control. As before, we observed a significant main effect of condition on anxiety,  $t(91) = 24.61$ ,  $p < 0.001$ ,  $d = 2.57$ , with participants reporting higher anxiety in the negative condition relative to the neutral condition.

### Hypothesis 1: Those With Dyslexia Will Show Higher Academic Anxiety Than Those Without Dyslexia

Again, we find students with dyslexia showed significantly higher emotional reactivity scores than those without dyslexia,  $t(90) = 2.48$ ,  $p = 0.015$ ,  $d = 0.52$ . This demonstrates a significant interaction for the group  $\times$  condition interaction,  $F(1, 90) = 6.136$ ,  $p = 0.015$ . Students with dyslexia found the negative conditions evoked much more anxiety than the neutral condition. This difference was attenuated in the students without dyslexia (Table 1).

### Hypothesis 2: Cognitive Reappraisal Is an Effective Strategy to Alleviate Academic Anxiety

As before, we find the use cognitive reappraisal significantly lowered anxiety,  $t(91) = 8.76$ ,  $p < 0.001$ ,  $d = 0.91$ . Participants had higher anxiety when they did not use reappraisal relative to when they did (Table 1).

### Hypothesis 3: University Students With Dyslexia Will Benefit More From the Cognitive Reappraisal Strategy Than Neurotypical Students

As before, students with dyslexia did not benefit from reappraisal more than those without dyslexia,  $t(90) = 0.65$ ,  $p = 0.519$ ,  $d = 0.14$ . This demonstrates a nonsignificant interaction for the groups on the negative and negative with reappraisal conditions,  $F(1, 90) = 0.420$ ,  $p = 0.519$ . Students with dyslexia found the negative change conditions evoked less anxiety than the negative condition. This difference was similar in the students without dyslexia.

### Exploratory Analyses

#### Generalized Versus Academic Anxiety

Participants with dyslexia did not show significantly higher generalized anxiety scores on the GAD-7 ( $M = 9.76$ ,  $SD = 5.42$ ) than participants without dyslexia ( $M = 8.18$ ,  $SD = 5.44$ ),  $t(90) = 1.39$ ,  $p = 0.169$ ,  $d = 0.29$ . In contrast, when examining academic anxiety as assessed by AAS, participants with dyslexia ( $M = 28.34$ ,  $SD = 6.09$ ) did show higher anxiety than students without dyslexia ( $M = 24.06$ ,  $SD = 8.31$ ),  $t(86.611) = 2.81$ ,  $p = 0.003$ ,  $d = 0.58$ . The correlation between GAD-7 and AAS was significant,  $r = 0.62$ ,  $p < 0.001$ .

#### Cognitive Reappraisal Use

Participants with dyslexia ( $M = 6.76$ ,  $SD = 2.02$ ) did not show different cognitive reappraisal use in daily life than

those without dyslexia ( $M = 6.75$ ,  $SD = 1.96$ ),  $t(90) = 0.026$ ,  $p = 0.979$ ,  $d = 0.006$ .

#### The Relationship Between Reading Skills and Emotional Reactivity

There was a significant difference between the groups on sight word efficiency,  $t(68.91) = 7.47$ ,  $p < 0.001$ , and phonemic decoding efficiency  $t(86) = 8.51$ ,  $p < 0.001$ . The dyslexia group had lower reading efficiency scores than the group without dyslexia.

A multiple regression analysis was conducted to assess the relative contribution of phonemic decoding and sight word efficiency on emotional reactivity scores, while controlling for age. This model was significant  $F(3, 82) = 4.12$ ,  $p = 0.009$ , accounting for 10% of variance ( $R^2 = 0.13$ ,  $\text{adj-}R^2 = 0.10$ ). The partial regression coefficients showed that only phonemic decoding had a significant unique negative relationship to emotional reactivity after controlling for age and sight word efficiency ( $B = -0.05$ ,  $\beta = -0.47$ ,  $t(83) = 2.98$ ,  $p = 0.004$ ). In other words, those with poorer phonemic decoding ability showed higher levels of emotional reactivity. Sight word reading efficiency was not independently associated with emotional reactivity  $B = 0.02$ ,  $\beta = 0.18$ ,  $t(83) = 1.11$ ,  $p = 0.272$ , neither was age ( $B = -0.08$ ,  $\beta = -0.13$ ,  $t(83) = 1.24$ ,  $p = 0.22$ ).

This pattern results are similar to when the mature students were included in the analysis.