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The effect of rapid automatized naming on foreign language anxiety among dyslexic students

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ABSTRACT

This study examined whether rapid automatized naming (RAN) training—a cognitive intervention focused on improving the speed and accuracy of naming visual stimuli—could effectively reduce foreign language anxiety (FLA) among dyslexic learners. Using a single-group pretest-posttest design with follow-up assessment, a 10-week RAN training intervention was implemented with 30 dyslexic students (18 males, 12 females; aged 13-14 years) from Egyptian preparatory institutes. The intervention consisted of individual 30-minute sessions conducted 3 times per week, systematically progressing from basic single-category naming tasks to complex mixed-category combinations designed to enhance processing fluency and automaticity. Using the foreign language classroom anxiety scale (FLCAS), anxiety levels were measured before intervention, immediately after, and at 8-week follow-up. Results revealed significant reductions in overall FLA (partial η^2=.32), with particularly notable improvements in communication apprehension (partial η^2=.33) and anxiety in the English classroom (partial η^2=.29). Test anxiety showed initial improvement but returned to near-baseline levels at follow-up, while fear of negative evaluation remained largely unchanged. Results suggest that RAN training may be associated with reductions in FLA among dyslexic students, though causal relationships cannot be established without a control group.

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1. INTRODUCTION

Dyslexia represents a complex neurodevelopmental, language-based disorder that extends far beyond basic reading difficulties to impact broader language acquisition processes fundamentally [1], [2]. At its core, this condition involves impaired phonological processing and significant difficulty in extracting morpho-phonological regularities, creating substantial obstacles for native and foreign language learning [1], [3]. Dyslexia encompasses persistent challenges across multiple linguistic domains, including phonological awareness, vocabulary acquisition, syntax processing, and spelling accuracy [4], [5]. These difficulties become particularly pronounced in foreign language contexts, where the implicit learning mechanisms that typically facilitate language acquisition are significantly compromised [6]. However, emerging research demonstrates that explicit instructional approaches, including cross-linguistic spelling instruction and phonics-based interventions, can promote positive transfer and substantially improve language learning outcomes [6]–[8].

Dyslexia significantly impacts foreign language acquisition, with dyslexic learners experiencing increased phonological processing difficulties, especially when dealing with orthographically opaque languages with irregular sound-symbol correspondences [9]–[11]. These students demonstrate pronounced decoding and word recognition deficits in foreign languages, especially when encountering unfamiliar grapheme-phoneme correspondences [12], [13]. Furthermore, dyslexic learners have weaker neural activation patterns for second-language vocabulary processing and reduced reading fluency compared to their monolingual counterparts [14]–[16].

Dyslexia is characterized by a cognitive and neurological deficit in phonological processing, causing difficulty in recognizing and manipulating speech sounds, directly affecting reading and spelling abilities [17], [18]. This phonological processing impairment is compounded by temporal processing difficulties that affect the precise sequencing of sounds and letters, which is crucial for accurate word formation and recognition [19], [20]. It is characterized by atypical brain structure and function in key language regions, including reduced activity in the left inferior frontal and middle temporal gyrus [21]. Additionally, increased neural noise and excitability in cortical networks disrupt the precise timing mechanisms required for fluent reading and effective print-speech integration [22]. Genetic factors, such as DNAAF4, DCDC2, and NRSN1 variants, affect brain function in language areas, influencing dyslexia susceptibility due to impaired auditory attention, procedural learning, and neural connectivity [23], [24].

Rapid automatized naming (RAN) is a cognitive process that involves rapid verbal naming of visual stimuli [25], [26]. RAN tasks measure the speed and accuracy with which individuals can name sequences of visually presented, well-known items, effectively reflecting the efficiency of visual-verbal integration and overall processing speed [27], [28]. Distinguished from phonological awareness, RAN provides unique predictive information about reading fluency and is a robust, independent predictor of reading difficulties, including dyslexia [26]. The predictive validity of RAN extends consistently across different languages and orthographic systems, suggesting that it captures universal cognitive mechanisms that are essential for successful reading development [29]–[31].

Research has consistently demonstrated that RAN performance shows a robust correlation with reading abilities, particularly reading fluency rather than accuracy, across diverse linguistic contexts [29], [32], [33]. This relationship is mediated by general processing speed and rapid visual-verbal mapping abilities, which represent fundamental components of language processing efficiency [34], [35]. Notably, the RAN-reading correlation remains consistent across diverse languages and bilingual populations, indicating that domain-general cognitive mechanisms drive this relationship, not language-specific skills [36], [37].

Foreign language anxiety (FLA) is conceptualized in educational psychology as a distinct, situation-specific form of anxiety that is explicitly experienced during second language acquisition, characterized by tension, apprehension, and fear in both classroom and communicative contexts [38], [39]. This construct encompasses four core dimensions: communication apprehension, fear of negative evaluation, test anxiety, and anxiety specific to the target language (conceptualized initially as “anxiety in English”) [40], [41]. FLA is primarily assessed using the foreign language classroom anxiety scale (FLCAS), a widely validated 33-item self-report instrument, with a reliable 8-item short form (S-FLCAS) also available for efficient assessment purposes [42], [43].

Empirical research has consistently demonstrated that FLA exhibits a moderate negative correlation with academic achievement across various language learning contexts and skill areas, including reading, writing, listening, and speaking [38], [41], [44]. This detrimental relationship becomes particularly pronounced in high-stakes testing situations and among students with lower self-efficacy beliefs [41]. The relationship between anxiety and performance can result in decreased willingness to communicate and increased communication apprehension [45], [46].

Dyslexic students encounter multifaceted challenges when acquiring foreign languages, primarily stemming from fundamental deficits in phonological processing and orthographic representation. These learners consistently struggle with identifying and differentiating sounds and letters, recognizing word patterns, and applying grammatical and spelling rules effectively [47], [48]. Additionally, they experience pronounced difficulties with accurate word recognition, poor spelling abilities, and compromised decoding skills, which significantly impact their reading fluency and overall comprehension [12], [49]. These phonological awareness deficits create persistent barriers to successful language acquisition.

Traditional foreign language teaching methods often fail to cater to the unique learning needs of dyslexic learners due to their reliance on uniform instructional approaches. These methods often lack differentiation or inclusive strategies, creating barriers to effective language acquisition [49], [50]. Furthermore, foreign language teachers often lack adequate awareness and training regarding dyslexia, limiting their ability to implement effective adaptations like multisensory instruction or individualized support strategies [49], [51]. These traditional approaches, often based on rote memorization and standardized tasks, fail to address the core challenges dyslexic students face in foreign language contexts [47], [52].

While extensive research has firmly established RAN as a robust predictor of reading difficulties and fluency across various populations [31], [34], [53], there remains a notable gap in the literature directly examining the relationship between RAN performance and anxiety levels. Current research primarily focuses on RAN's associations with phonological processing, reading accuracy, future reading performance and arithmetic skills [54]–[57], while studies investigating emotional factors and their interactions with cognitive processing remain limited. Despite RAN strong predictive validity, no studies have explored how anxiety levels might influence RAN task performance or how RAN interventions might impact anxiety levels, highlighting a critical research gap in understanding the effect of RAN intervention strategies on fluency.

Understanding the relationship between RAN and FLA in dyslexic students is crucial for developing effective educational interventions. RAN deficits predict reading difficulties and are a universal marker of developmental dyslexia [58]. Dyslexic students often exhibit elevated FLA levels, which worsen academic challenges and hinder language learning outcomes [59]. Anxiety, combined with RAN processing difficulties, can impair cognitive efficiency and emotional well-being during language acquisition [60]. By examining these factors systematically, educators can implement targeted interventions addressing cognitive and affective domains, supporting dyslexic students' academic success and reducing barriers to foreign language acquisition. This study investigates the effectiveness of RAN training as a targeted intervention strategy for reducing FLA among dyslexic students. The proposed 10-week program aims to address cognitive processing challenges that contribute to heightened anxiety in language learning contexts. The findings could contribute to developing evidence-based intervention strategies specifically designed for dyslexic learners in foreign language contexts.

2. METHOD

2.1. Study design

The study employed a single-group pretest-posttest-follow-up quasi-experimental design to examine the effectiveness of RAN training on FLA among dyslexic students. While acknowledging that the absence of a control group represents a significant methodological limitation affecting internal validity, this design was selected due to ethical considerations regarding withholding potentially beneficial interventions from dyslexic students and practical constraints within the rural school setting. The design included pre-intervention baseline assessment, immediate post-intervention assessment within one week, and follow-up assessment 8 weeks post-intervention to evaluate both immediate treatment effects and maintenance of gains.

2.2. Participants

The study included 30 students (18 males, 12 females) in their second year of preparatory stage, identified as having dyslexia from two preparatory institutes in Gharbeya Governorate, Egypt. Ages ranged from 13 to 14 years (M=13.17, standard deviation (SD)=.38). Participants were selected from a comprehensive screening of 292 students with learning difficulties across six specialized learning disorder classes within these institutions. Gharbeya Governorate was chosen for its rural educational characteristics and specialized learning disorder programs within the Egyptian system. The governorate maintains typical rural infrastructure and special education services for students with learning disabilities. The study offers insights into intervention effectiveness within rural educational contexts. The Egyptian preparatory curriculum mandates foreign language education, with students receiving about 8 years of compulsory English instruction.

A comprehensive diagnostic assessment was conducted to confirm the dyslexia diagnosis and establish baseline functioning. The screening protocol included standardized multiple evaluations, including Raven's Progressive Matrices for non-verbal intelligence, the Dyslexia Early Screening Test-Second Edition for dyslexia-related characteristics, and the reading assessment for Arabic reading fluency. Participants demonstrated significant deficits in rapid naming speed, phonological awareness, and working memory span, confirming dyslexia diagnosis criteria. The reading assessment revealed substantial reading difficulties, with an average reading rate of 45 words per minute, and performance approximately 2-3 grade levels below chronological grade placement. The screening protocol ensured that participants demonstrated average cognitive functioning and could perform at their grade level.

2.3. Measures

The FLCAS [40] assessed participants' FLA levels. This 33-item scale asks students to rate situations related to foreign language learning anxiety on a 5-point Likert scale from "strongly disagree" to "strongly agree". Total scores range from 33 to 165, with higher scores indicating greater anxiety. FLCAS measures four components of FLA: communication apprehension (11 items), test anxiety (3 items), fear of negative evaluation (9 items), and anxiety in the English classroom (10 items). It was translated from English to Arabic using a systematic forward-backward approach involving bilingual experts. The process included

forward translation, followed by backward translation, with cross-checking and reconciliation to ensure semantic equivalence and cultural appropriateness. In this study, FLCAS focused on English language learning anxiety, aligning with the Egyptian preparatory school curriculum where English is the mandatory foreign language.

The FLCAS demonstrated strong internal consistency reliability when administered to 137 students with learning disabilities or dyslexic students across five schools in Gharbeya Governorate, with a Cronbach's alpha coefficient of .91 for the total scale. The subscale reliability coefficients were also satisfactory, ranging from .83 to .88 (communication apprehension=.88, test anxiety=.84, fear of negative evaluation=.86, and anxiety in the English classroom=.83). Composite reliability (CR) values indicated good construct reliability for all subscales: communication apprehension (CR=.89), test anxiety (CR=.87), fear of negative evaluation (CR=.88), and anxiety in the English classroom (CR=.55).

The confirmatory factor analysis demonstrated good model fit for the four-factor structure of the FLCAS, with the following fit indices: χ^2 (489)=742.36, p<.001; χ^2/df=1.52; comparative fit index (CFI)=.94; Tucker–Lewis index (TLI)=.93; root mean square error of approximation (RMSEA)=.06 (90% confidence interval (CI) [.05, .06]); and standardized root mean square residual (SRMR)=.048. The standardized factor loadings for all items were statistically significant (p<.01), ranging from .62 to .84. The average variance extracted (AVE) values provided evidence of adequate convergent validity: communication apprehension (AVE=.57), test anxiety (AVE=.54), fear of negative evaluation (AVE=.55), and anxiety in the English classroom (AVE=.53).

2.4. Intervention protocol

The 10-week RAN training intervention was designed as a structured, progressive program delivered through individual 30-minute sessions three times per week, with participants attending a minimum of 24 sessions (80%) of the total 30 potential training sessions. The RAN training was conducted in Arabic, the participants' native language, to ensure maximum comprehension and engagement during the intervention. Table 1 outlines the comprehensive structure and requirements of the RAN training program.

Training sessions were designed to maximize learning and engagement, structured over 30 minutes. Each session began with a warm-up, followed by explicit instruction, guided practice, independent practice, and progress monitoring. Difficulty progression was crafted to challenge cognitive processing and naming speed by expanding stimulus categories, reducing structural predictability, and introducing more demanding naming configurations. This ensured students received feedback and goals were adjusted as needed. Session fidelity was monitored using a standardized checklist and audio recordings. Mean treatment integrity was 94.2%, indicating high consistency in delivery. Weekly supervision meetings addressed implementation challenges and maintained protocol adherence. Inter-rater reliability for integrity scoring was established using 15% of recorded sessions, with two independent raters achieving 92% agreement on adherence items.

Table 1. Structure and requirements of the 10-week RAN training program

	Module	Weeks	Focus areas	Activities
1.	Basic naming speed	1-2	Single-category stimuli	- Week 1: letter naming (uppercase/lowercase), number naming (forward/backward) - Week 2: mixed letter-number combinations
2.	Complex naming speed	3-4	Additional stimulus categories	- Week 3: color and object naming - Week 4: alternating patterns of colors and objects
3.	Mixed category integration	5-6	Multiple stimulus integration	- Week 5: structured combinations (letters, numbers, colors, objects) - Week 6: semi-random combinations with consistent groupings
4.	Advanced integration and automaticity	7-10	Automaticity and generalization	- Weeks 7-8: random combinations without patterns - Weeks 9-10: complex mixed arrays with increased density

2.5. Procedure

The students were tested individually in a quiet room at school across two sessions, one week apart. The first session involved administering pretesting measures. Each assessment lasted about 15–20 minutes, during which participants completed the FLCAS questionnaire. The pre-intervention session included brief demographic data collection, extending total duration to approximately 25–30 minutes. After pretesting, all participants completed a 10-week RAN training program delivered by researchers, a certified special education teacher, and a reading specialist. Training occurred individually for 30 minutes, 3 days per week during school hours in a quiet classroom. Within 1 week of completing the intervention, students were scheduled for post testing by a research assistant blinded to the purpose of the RAN program. The FLCAS was readministered in the same format as the pretest. Follow-up test was conducted 8 weeks later to assess gains.

2.6. Data analysis

Data analysis was conducted using SPSS version 27.0. The primary analytical approach was a one-way repeated measures analysis of variance (ANOVA) with time (pre-intervention, post-intervention, follow-up) as the within-subjects factor. This design enabled examination of changes in FLA across three measurement points while controlling for individual differences. Significance was set at $p<.01$, with effect sizes calculated using partial eta squared (η^2). Assumptions for repeated measures ANOVA were verified prior to analysis, including sphericity via Mauchly's test.

3. RESULTS

A one-way repeated measures ANOVA was conducted to comprehensively assess the impact of the 10-week RAN training intervention across multiple anxiety components measured by the FLCAS. Tests of within-subject effects were employed to evaluate changes over time while controlling for individual differences among participants, with effect sizes calculated using SPSS-27 software. F-values served as the primary statistical indicator for determining the significance of differences between measurement periods. The detailed statistical findings are presented in Tables 2 and 3.

The analysis revealed statistically significant changes in several key anxiety components based on F-values obtained from tests of within-subject effects. Communication apprehension exhibited the most pronounced improvement, with F-value of 14.39 ($p<.01$) indicating significant differences across measurement periods. The large effect size (partial $\eta^2=.33$) demonstrates that the RAN training intervention had substantial impact on reducing communication-related anxiety among dyslexic students. This component showed remarkable consistency in improvement, maintaining reduced anxiety levels from post-intervention through the follow-up period, as presented in Figure 1. The total FLCAS score showed substantial reduction with F-value of 13.63 ($p<.01$) and large effect size (partial $\eta^2=.32$), as calculated by SPSS-27. The intervention resulted in a meaningful decrease in overall FLA, with scores dropping significantly from pretest to posttest phases.

Table 2. FLCAS components across pre-intervention, post-intervention, and follow-up measurements

Variable	Pretest		Posttest		Follow-Up		F value	partial η^2
	M	SD	M	SD	M	SD		
Communication apprehension	34.50	5.29	28.93	3.86	29.23	4.23	14.39**	.33
Test anxiety	9.43	1.79	7.17	1.62	9.03	1.97	12.23**	.29
Fear of negative evaluation	26.70	4.38	25.27	4.35	26.03	6.36	.64	.02
Anxiety of English classroom	32.17	4.11	27.00	4.31	26.77	5.71	11.99**	.29
Total FLCAS	102.80	10.12	88.37	10.36	91.07	14.26	13.63**	.32

Note: **=p<.01; M=mean; partial η^2 indicates effect size.

Table 3. Pairwise comparisons of mean differences in FLCAS components across measurement periods

Variable	Mean diff (pre-post)	Mean diff (post-follow-up)	Mean diff (pre-follow-up)
Communication apprehension	5.57**	-.30	5.27**
Test anxiety	2.26**	-1.86**	.40
Fear of negative evaluation	1.43	-.76	.67
Anxiety of English classroom	5.17**	.23	5.40**
Total FLCAS	14.43**	-2.70	11.73**

Note: **=p<.01.

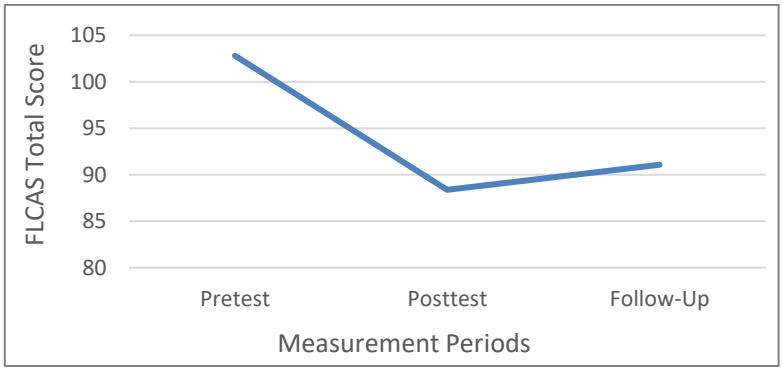

Figure 1. Total FLCAS mean scores across three measurement periods (N=30)

As illustrated in Figure 1, the trajectory of total FLCAS mean scores demonstrates a clear pattern of improvement following the RAN intervention. This graphical display reinforces the statistical findings and provides clear evidence of the intervention's effectiveness in reducing overall FLA among dyslexic students. Test anxiety demonstrated significant improvement with F-value of 12.23 ($p<.01$) and large effect size (partial $\eta^2=.29$). The intervention produced notable reductions in test-related anxiety immediately following the training period. However, the follow-up measurements revealed a rebound effect, with anxiety levels returning closer to baseline, indicating that this component may require ongoing support to maintain long-term benefits.

Anxiety related to the English classroom showed significant improvement with an F-value of 11.99 ($p<.01$) and a large effect size (partial $\eta^2=.29$). The intervention effectively reduced classroom-specific anxiety, with improvements maintained through the follow-up period. The sustained reduction suggests that RAN training helps students develop lasting comfort and confidence in English learning environments. Fear of negative evaluation demonstrated the least responsiveness to the RAN training intervention, with an F-value of .64 (non-significant). This component showed minimal changes across all measurement periods, suggesting that fear of negative evaluation might necessitate more targeted therapeutic strategies.

The comparative analysis of mean differences provided deeper insights into intervention effectiveness and sustainability patterns. Following the significant repeated measures ANOVA results, Bonferroni-corrected pairwise comparisons were conducted to examine specific differences between measurement time points. These post-hoc analyses revealed significant reductions from pre-intervention to post-intervention in communication apprehension (mean difference=5.57, $p<.01$), test anxiety (mean difference=2.26, $p<.01$), and anxiety in the English classroom (mean difference=5.17, $p<.01$). The magnitude of these changes, particularly the 14.43-point reduction in total FLCAS scores ($p<.01$), demonstrates the intervention's impact on FLA.

4. DISCUSSION

The findings of this study provide preliminary evidence suggesting a potential association between RAN training and reductions in FLA among dyslexic students. However, the single-group design limits our ability to establish causal relationships, as alternative explanations for the observed improvements cannot be ruled out. The differential patterns of improvement across anxiety dimensions suggest that cognitive training approaches can effectively target specific aspects of language learning anxiety, particularly those related to processing efficiency and classroom performance. The discussion of these results reveals promising developments and areas requiring further investigation, with implications for theoretical understanding and practical implementation in educational settings.

The significant decrease in communication apprehension represents one of the study's most notable findings, aligning with previous research by Araújo *et al.* [61] suggesting that literacy experience enhances the automaticity with which visual stimuli can be retrieved and named, particularly for low-frequency items from sparse phonological neighborhoods. This improvement supports the theoretical framework proposed by Kormos [62], who argue that automaticity in language processing frees up cognitive resources for real-time language production and perception. The substantial effect size indicates that RAN training effectively addressed one of the primary anxiety triggers for dyslexic language learners [63], [64].

The study found that classroom anxiety decreased after RAN training, which supports the idea that processing inefficiencies are a major contributor to anxiety among dyslexic students [65]. However, the complex pattern of test anxiety in foreign language learning, especially for dyslexic students, requires further investigation [40], [63]. The persistence of fear of negative evaluation during the intervention period highlights the limitations of cognitive-focused interventions, suggesting that addressing fear of negative evaluation may require interventions targeting social-emotional aspects of language learning, beyond the scope of RAN training alone [66].

The study supports the double-deficit hypothesis that phonological awareness and naming speed contribute to reading difficulties [67]. It suggests that enhanced naming speed may improve language processing and reduce anxiety, especially in communication-based contexts where automaticity is most beneficial. Temporary improvements in test anxiety highlight the need for comprehensive interventions addressing cognitive and emotional aspects of language learning anxiety. Integrating RAN training with emotion regulation strategies may offer a more complete approach to anxiety reduction, addressing cognitive efficiency and emotional regulation needs.

The study on RAN training effectiveness in adolescents has limitations, including absence of a control group, modest sample size, and specific demographic characteristics of rural Egyptian preparatory students. These factors limit findings generalizability to other populations, educational contexts, and cultural settings. The study also faces potential selection bias due to non-randomized recruitment from specialized

learning disorder classes, lack of protocol pre-registration, and reliance on self-report anxiety measures. The brief follow-up period of 8 weeks may not capture long-term effects or identify factors predicting sustained anxiety reduction, especially given the complex, persistent nature of dyslexia and anxiety disorders.

Future research should include randomized controlled trials, comprehensive RAN performance assessments, multiple assessment methods, investigation of moderating variables, longitudinal studies examining long-term anxiety reduction effects, and combined interventions targeting cognitive and emotional aspects of FLA. These improvements will help establish causal relationships between RAN training and anxiety reduction while identifying optimal implementation parameters. Particularly important is developing combined intervention protocols that integrate RAN training with social-emotional learning components to address persistent fear of negative evaluation observed in this study.

5. CONCLUSION

This study investigated the effectiveness of RAN training in reducing FLA among dyslexic students, as hypothesized in the Introduction. The results confirmed that the 10-week RAN intervention significantly decreased overall FLA, with the most pronounced reductions in communication apprehension and classroom-specific anxiety. At the same time, fear of negative evaluation showed minimal change. The study outcomes underscore the potential of RAN training as a targeted intervention for dyslexic learners, particularly in enhancing processing efficiency and reducing performance-related anxieties. However, the persistent fear of negative evaluation suggests the need for complementary social-emotional strategies. Future research should incorporate controlled designs to isolate RAN-specific effects and explore long-term sustainability.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

Written informed consent was obtained from all participants and their parents after explaining the study's purpose, procedures, risks, and benefits, following ethical guidelines and institutional approval.

ETHICAL APPROVAL

The study protocol was approved by the Research Ethics Committee of the Faculty of Education, Al-Azhar University, Egypt (Ref. No. EDU-REC-2023-2358).

DATA AVAILABILITY

The data are available from the corresponding author, [MAN-a], upon reasonable request.

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