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Effectiveness of Cognitive Behavioral Group Therapy (CBGT) in Reducing Math Anxiety among Adolescents

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Abstract

The current study examines the effectiveness of Cognitive Behavioral Group Therapy (CBGT) in reducing math anxiety among adolescents. It was conducted using the experimental method. The sample consisted of 24 high math anxious students based on the Abbreviated Math Anxiety Rating Scale (A-MARS) scores with ages between 13-17 years. The participants were randomly assigned to experimental and control groups with 12 subjects in each group. There were 5 male and 7 female students in the experimental group, while the control group comprised 6 male and 6 female students. Pre-testing was followed by the intervention given to the experimental group in the form of 16 sessions of tailored CBGT, involving a 90 minute session conducted twice a week. Both groups were tested again using A-MARS after the intervention was terminated. Statistical analysis of the data was done using descriptive statistics, as well as paired and independent sample t-tests. Data analysis revealed the high statistical significance of the intervention, proving CBGT to be highly effective in reducing math anxiety and three subscales of A-MARS: math test anxiety, math course anxiety and numerical anxiety. This experimental research is implicative for therapists, school psychologists, educators and parents of math anxious children.

Keywords: adolescents, Cognitive Behavioral Group Therapy (CBGT), high school students, math anxiety

Introduction

Math anxiety is an anxious experience associated with situations in individuals' academic life which require them to perform mathematical tasks, either during learning or while being evaluated in mathematics. Math anxious students are often labeled as poor learners. It leads to the feelings of discomfort, apprehension and avoidance, subsequently yielding in disappointingly low levels of both mathematics performance and mathematics achievement (Ashcraft, [2002](#)).

Dreger and Aikens ([1957](#)) said that math anxiety is different from test anxiety. It exists in schools and remains an important concern since its

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identification (Karimi & Venkatesan, [2009](#)). It also affects the students' choice of career. Suinn et al. ([1982](#)) stated that math anxiety influences many people and jeopardizes their achievements and performance. Tobias ([1987](#)) called it "sudden death".

Symptoms of Math Anxiety: The symptoms include physiological and psychological symptoms similar to that of the other types of anxiety. Physiological symptoms include muscle tension, headache, an irregular heartbeat, stomach disturbances, hot flashes, increased sweating, clammy hands and feet (Clawson, [1991](#), p.2; Godbey, [1997](#); Perry, [2004](#)). Similarly, feelings of apprehension / fear / worry, confusion and nervousness, escaping the situation, difficulty in coping, fear of failure and humiliation, negative self-talk, negative automatic thoughts, attending negative aspects more readily, being blank minded and failure to recall previously learnt materials (Ashcraft & Kirk, [2001](#); Clawson, [1991](#), p.2; Godbey, [1997](#); Perry, [2004](#)) are also among the symptoms.

Neurological Basis of Math Anxiety: Young et al. ([2012](#)) analyzed data brain-imaging (fMRI) of 7-9 year old children while solving the problems of addition and subtraction. Increased activity was detected in fear-associated brain regions in students who felt "panicky" about math. With the activation of these areas, brain activity in areas involved in problem solving decreased.

Pletzer et al. ([2015](#)) compared the mathematical performance of High Math Anxious individuals (HMAs) and Low Math Anxious individuals (LMAs) on two tasks, that is, number comparison and number bisection. Deactivation within the Default Mode Network (DMN) was detected in LMAs in comparison to HMAs during both tasks, not affecting the number associated areas of the adult brain.

Causes of Math Anxiety: According to Hadfield and McNeil ([1994](#)), the factors causing math anxiety can be classified into personality factors (shyness, having low self-esteem, and perception of math as males' attribute), intellectual factors (negative attitude, low self-confidence, and not believing that mathematics is purposeful), and environmental factors (detrimental classroom events, careless teachers, and demanding parents). The root cause of math anxiety is the way a teacher teaches mathematics in the class (Fiore, [1999](#); Harper & Daane, [1998](#)),

Possible Effects of Math Anxiety: Anxiety related to math is aggravated gradually with the passage of time and can affect math learners in various ways. Math anxiety may begin anytime during the school going age, even in primary classes, although 7th-10th grade students often have the most negative experiences (Clawson, [1991](#), p.2). If math anxiety is not effectively dealt with, it often continues

and may worsen for high school and college students and even for adults. Individuals experiencing high math anxiety avoid situations requiring mathematics more willingly and are far less likely to pursue Science, Technology, Engineering, and Mathematics (STEM) related careers as compared to individuals with low math anxiety (Supekar, et al [2015](#)). Commencing in primary school age, math anxiety and its consequences keep worsening with time, thus resulting in lifelong negative effects on the achievement and experiences of math and expand math avoidance (Young, et al. [2012](#)).

Treatment Choices for Math Anxiety: Zettle (2003) compared the effectiveness of systematic desensitization and the Acceptance and Commitment Therapy (ACT) for treating math anxiety. He concluded that systematic desensitization is relatively more effective in reducing trait anxiety and more individuals improve at follow-up.

Supekar et al. ([2015](#)) found cognitive tutoring to be significantly effective in treating math anxiety. Genshaft ([1982](#)) found Cognitive Behavioral Therapy (CBT) useful in treating math anxiety in adolescent girls. The sample was split into three groups like received CBT, math tutoring and no treatment. The results showed that both CBT and tutoring decreased math anxiety, whereas CBT also yielded in increased performance.

Karimi and Venkatesan ([2009](#)) studied the effectiveness of Cognitive Behavioral Group Therapy (CBGT) for math anxiety in adolescent boys and girls. The experimental group showed significant improvement as compared to the control group, proving CBGT as an effective therapeutic intervention in reducing math anxiety. This study involved the desensitization of math material which makes it difficult to weigh exactly the percentage effect brought about by CBGT and exposure to math, separately.

Rationale of the Study

Pakistan, as a developing country, needs a high number of experts in STEM fields. Lacking these experts would result in no or very little progress and development. Math anxiety is required to be effectively dealt with in order to minimize its limiting effect on students' career choices. Being an educator of science and math since 2015, I have observed that many students dislike math and avoid everyday situations involving even basic calculations. This caused me to seek the aid of psychotherapy to alleviate math anxiety and to help students flourish in the fields of mathematics and technology. In Pakistan, few studies have been carried out in this regard, especially intervention based studies. This research intends to explore

the effectiveness of CBGT for treating math anxiety in adolescents so that they may adopt math involving careers without hesitation.

Hypotheses

The current study is based on the following hypotheses.

- 1.CBGT is significantly effective in treating math anxiety in adolescents.
- 2.CBGT is effective in treating math test anxiety.
- 3.CBGT is an effective treatment for math course anxiety.
- 4.CBGT is effective in treating numerical anxiety.

Method

Participants

The participants of this study were 9th and 10th grade students of Muslim Public Higher Secondary School, Multan. Math is a compulsory subject for these classes. The age range of students was 13 to 17 years. Both male and female students participated in the study. The A-MARS was filled up by 200 students of 9th and 10th grades. All 24 individuals who scored 100 or more were included in the study. Furthermore, they were assigned to either the experimental or control group, randomly. There were 12 students in each group.

Measure

Demographic information sought from the participants included their class, age and gender. The A-MARS scale developed by Alexander and Martray (1989) was used for measuring math anxiety. It is a concise version of the Mathematics Anxiety Rating Scale (MARS) developed by (Richardson & Suinn, 1972).

A-MARS is a self-reporting scale. It consists of 25 items and measures anxiety on a 5-point likert scale, with score 1 for 'no anxiety at all' and 5 for 'very much anxiety'. Score points range between 25-125. The higher the score of an individual, the higher level of math anxiety that individual has.

Design

Independent measures or experimental design was used in this study. Both random selection and random assignment techniques were employed.

Procedure

First of all, permission was sought to use A-MARS from the author through e-mail. Mr. Saleem Taunsvi, the principal of the Muslim Public Higher Secondary School, also granted permission to conduct this experimental study in his school.

Initial testing was done to identify high math anxious students. Then, these students were randomly assigned to either experimental or control group. Those assigned to the experimental group (5 males and 7 females) received 16 sessions of tailored CBGT, delivered as two sessions per week. Each session was 90 minutes long and co-led by two trained psychologists. A comfortable environment and treatment protocol was maintained during the intervention. The participants were provided with a booklet comprising the session's material summary, worksheets related instructions and worksheets to be used in the sessions and for home assignments. Tailored CBGT included techniques for regulating emotions and coping with math anxiety effectively, behavioral strategies for managing physical symptoms, cognitive restructuring and assertiveness training to empower students and to enable them to combat humiliation and failure, thus psycho-educating the participants. Control group didn't receive any intervention / treatment. After two days of the termination of CBGT, both experimental and control groups were post-tested using A-MARS at the same time. The datasets were then analyzed using the Statistical Package for Social Sciences (V 22).

Results

SPSS 22.0 was used for data analysis in this research. The results are based on a 95% confidence interval ($p < 0.05$). Mean, standard deviation, paired sample t-test and independent sample t-test were used to compare control (no treatment group) and experimental groups (treated with CBGT) with each other in order to determine the effectiveness of CBGT for minimizing math anxiety in adolescents.

Table 1

Paired Sample t-test Comparison of Math Anxiety Level on A-MARS

	Group	Before		After		t	p	Cohen's d
		Intervention		Intervention				
		M	SD	M	SD			
A-MARS	Experimental	4.33	.14	2.63	.26	21.230	.000	8.14
	Control	4.34	.19	4.34	.18	-.183	.858	

$df = 11, p < 0.05$

The results of the paired sample t-test in Table 1 indicate that CBGT has an impact on adolescents with high levels of math anxiety. Twelve participants completed a CBGT intervention in two months. There was a statistically significant decrease in A-MARS scores after administering CBGT ($M = 2.63, SD = .26$) ($t(11) = 21.230, p < 0.000$). The mean decrease in scores was 1.7 at 95% confidence interval. The value of Cohen's d is 8.14 which shows a large effect size.

Table 2*Paired Sample t-test Comparison of Math Test Anxiety*

	Group	Before		After		t	p	Cohen's d
		Intervention		Intervention				
		M	SD	M	SD			
MTA	Experimental	4.32	.21	2.94	.33	14.015	.000	4.99
	Control	4.45	.18	4.44	.17	.340	.740	

$df= 11, p<0.05$

Table 2 presents the results of the paired sample t-test. The experimental group received CBGT intervention for two months. There was a statistically significant decrease in A-MARS scores after administering CBGT ($M=2.94, SD=.33$) ($t(11)=14.015, p<0.000$). Mean decrease in scores was 1.38 at 95% confidence interval. The value of Cohen's d is 4.99, exhibiting the effect size for the therapeutic intervention as large ($d>0.8$).

Table 3*Paired Sample t-test Comparison of Math Course Anxiety*

	Group	Before		After		t	p	Cohen's d
		Intervention		Intervention				
		M	SD	M	SD			
MCA	Experimental	4.32	.22	2.35	.31	28.243	.000	7.33
	Control	4.19	.33	4.28	.31	-.787	.448	

$df= 11, p<0.05$

The results of the paired sample t-test in Table 3 show that CBGT has an impact on adolescents experiencing high math anxiety. CBGT intervention was received by the experimental group participants. There was a statistically significant decrease in A-MARS scores after receiving CBGT sessions ($M=2.35, SD=.31$) ($t(11)=28.243, p<0.000$). The mean decrease in the score was 1.97 at 95% confidence interval. Effect size is large as indicated through the value of Cohen's d (7.33).

Table 4 shows paired sample t-test results. There was a statistically significant decrease in A-MARS scores after administering CBGT ($M=2.35, SD=.66$) ($t(11)=9.950, p<0.00$). The mean decrease in scores is 2.00 at 95% confidence interval. The value for Cohen's d is 3.95, which represents the large effect size of the intervention.

Table 4*Paired Sample t-values of Numerical Anxiety*

	Group	Before		After		t	p	Cohen's d
		Intervention		Intervention				
		M	SD	M	SD			
NA	Experimental	4.35	.28	2.35	.66	9.950	.000	3.95
	Control	4.28	.31	4.22	.27	.586	.570	

*df= 11, p<0.05***Table 5***Independent Sample t-test for Total Math Anxiety Scores on A-MARS*

	Group	Before				After			
		Intervention		T	p	Intervention		t	p
		M	SD			M	SD		
A-MARS	Experimental	4.33	.14	.098	.92	2.63	.26	18.638	.000
	Control	4.33	.19			4.34	.18		

df=22, p<0.05

Table 5 shows the results of the independent sample t-test for the pre- and post-intervention scores of A-MARS scores which differ for experimental and control groups. No significance difference was found in the pre-test scores of the experimental group (M=4.33, SD =0.14) and the control group (M=4.34, SD=0.19) ($t(22) = .098, p=0.92$). However, a significant difference was found in the post-test scores obtained for the experimental group (M=4.2.63, SD=0.18) and the control group (M=4.34, SD=0.18) ($t(22) = 18.638, p=.000$) at 0.05 significance level.

Table 6*Independent Sample t-test comparison of Math Test Anxiety Domain*

	Group	Before				After			
		Intervention		T	p	Intervention		t	p
		M	SD			M	SD		
MTA	Experimental	4.32	.21	1.574	.130	2.94	.33	14.055	.000
	Control	4.45	.18			4.44	.17		

df=22, p<0.05

Table 6 depicts the results of the independent sample t-test conducted to assess whether the experimental and control group differ in terms of pre- and post-intervention scores of math test anxiety domain. The analysis revealed that there is no significant difference in the pre-test scores obtained for both the experimental group (M=4.32, SD =0.21) and the control group (M=4.45, SD=0.18) ($t(22) = 1.574, p=0.130$). The results also revealed that the post-test scores obtained for the experimental group (M=2.94, SD=0.33) and those of the control group (M=4.44, SD=0.17) ($t(22) = 14.055, p=.000$) were significantly different at 95% confidence interval.

Table 7*Independent Sample t-test Comparison of Math Course Anxiety Domain*

Group	Before Intervention				After Intervention			
	M	SD	t	p	M	SD	t	p
Experimental	4.32	.22	-1.143	.265	2.35	.31	15.535	.000
Control	4.19	.33			4.29	.30		

$df=22, p<0.05$

Table 7 depicts the results of the independent sample t-test regarding whether the experimental and control group differ in pre- and post-intervention scores of math course anxiety. No significant difference was detected in the pre-test scores obtained for the experimental group (M=4.32, SD =0.22) and the control group (M=4.19, SD=0.33) ($t(22) = -1.143, p=0.265$). However, a significant difference was found in the post-test scores obtained for the experimental group (M=2.35, SD=0.31) and the control group (M=4.29, SD=0.30) ($t(22) = 15.535, p=.000$) at 95% confidence interval.

Table 8*Independent Sample t-test Comparison of Numerical Anxiety Domain*

Group	Before Intervention				After Intervention			
	M	SD	t	p	M	SD	t	p
Experimental	4.35	.28	-.574	.572	2.35	.66	9.149	.000
Control	4.28	.31			4.22	.27		

$df=22, p<0.05$

Table 8 depicts the results of the independent sample t-test regarding whether the experimental and control group differ in pre- and post- scores for numerical anxiety. There was no significant difference found in the pre-test score of both the experimental group (M=4.35, SD =0.28) and the control group (M=4.28, SD=0.31) ($t(22) = -0.574, p=0.572$). However, a significant difference was found in the post-test scores obtained for the experimental group (M=2.35, SD=0.66) and the control group (M=4.22, SD=0.27) ($t(22) = 9.149, p=.000$) at 95% confidence interval.

Discussion

This study was aimed to determine the effectiveness of CBGT for reducing math anxiety in adolescents. The results indicated that CBGT has a reducing effect in the levels of the math anxiety of adolescents. Thus, the stated hypotheses proved to be correct and in-line with the previous findings. Genshaft (1982) considered Cognitive Behavioural Therapy (CBT) as the treatment of choice for math anxiety. Hembree (1990) found that psychotherapeutic interventions, for example, CBT, anxiety managing techniques and systematic desensitization are effective in alleviating math anxiety. The current study found CBGT to be significantly effective for treating math test anxiety, math course anxiety and numerical anxiety. Karimi and Venkatesan (2009) also found CBGT effective in the treatment of math anxiety in high school students in Iran. They concluded CBGT as effective in reducing math test anxiety and numerical anxiety.

Implications

The current study has implications for school psychologists, clinical psychologists, educators, parents and students. It highlights the effectiveness of CBGT in adolescents. CBT offers many self-help skills to general public, helping them to cope with their anxiety. This study encourages the professionals to tailor CBT for clients having math anxiety. Moreover, it encourages the general public to find a way to rid themselves of a hurdle to success in the tech world, that is, math anxiety.

Limitations

No research is free of limitations. The current study was conducted in a single public school, thus it has limited external validity. Moreover, it utilized the self-report measure, thus the data may contain the response bias effect. Lastly, it only took into account the students of class 9th and 10th, thus it has a limited scope.

Suggestions / Recommendations

Research should be conducted involving different age groups, academic levels,

geographical areas and larger samples to enhance external validity and to make effective generalizations. There should be comparative evaluations of behavioral and cognitive interventions separately in order to weigh their respective outcomes. Interventions other than CBT should be explored for their effectiveness in the Pakistani context. Gender differences should also be analyzed.

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