High-expectation comments increase students' mental activity and confidence in the test

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Abstract. Past research has consistently found that teachers' expectations for students' performance shape their long-term academic success. This study extends this work by examining possible short-term pathways through which instructors' test-related expectations may influence their academic success, specifically students' confidence, mental activity and immediate test score performance. It was hypothesized that after receiving high-expectation encouragement, students would have experience greater confidence, superior immediate test performance, and stronger gamma waves (i.e., brain waves that indicate more intense mental activity). To test these hypotheses, an experiment was conducted with nine students from Guangxi, China. Results showed that students who received high-expectation comments tended to generate stronger EEG gamma waves and experience higher levels of confidence. However, no relationship was found between the expressed expectation and students' test scores. Future experiments with a larger participant pool can build upon the preliminary outcomes of my study.

1 Introduction

1.1 Teachers' expectations for students: a self-fulfilling prophecy

Teachers' expectations of their students' ability play a critical role in shaping students' learning experiences. Teachers with high-expectations motivate their students through verbal and behavioral encouragement, which eventually improves students' academic performance [1]. Though educators' expectations have no immediate impact on students' intelligence, it is believed that these expectations can change students' attitudes towards learning, which can impact their success in school. For example, students who are held to high expectations tend to be more engaged in class, and they demonstrate greater motivation to learn [2].

Nonetheless, previous research has mostly studied the effect of educators' expectations on more long-term outcomes (i.e., at least one semester long); few studies have explored the immediate impact of high expectations on students' performance during individual tests. For this reason, the author devised a study to investigate how educators' expectations could affect test-takers' self-esteem and mental activity when taking a test. Toward this goal, the study collected data on student participants' brain waves because certain brain waves are significantly correlated to cognitive tasks [3]. The following section provides an overview of brain waves, why they are suited for the goals of these study, and how they can be measured.

1.2 Brain waves, Gamma waves and Muse headbands

The human brain is made up of billions of cells called neurons. When a group of neurons is activated, the neurons produce rhythmic electric oscillation patterns known as brain waves. Traditionally, brain waves are divided into five different categories based on their frequency, which is typically measured in terms of the number of oscillations per second (hertz). The five types of brain waves are delta waves (0.5-4 hertz), theta waves (4-8 hertz), alpha waves (8-13 hertz), beta waves (13-32 hertz) and gamma waves (32-100 hertz).

Previous studies have explored the roles of gamma waves during cognitive tasks. For example, in a 2004 study, the strength of gamma waves increased significantly when test participants were reading, learning and calculating [3]. It was reported that the strength of gamma waves could indicate the onset and variation of cognitive processing [4]. Therefore, this paper chooses to investigate the variance of gamma waves to understand how students' brain activity changed during the test; for example, an increase in their mental activity should be reflected by stronger gamma waves.

Because all brain waves are essentially electrical impulses, they can be detected by electrodes placed on the scalp. An electroencephalogram (EEG) device is a brain-measuring tool that contains such electrodes. In order to track participants' gamma waves in this research, the author used a Muse headband – a portable and wireless EEG device. There are four electrodes in Muse headband: two on the forehead and two behind the ears. The Muse

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headband was originally designed to facilitate meditation, but many researchers used Muse in their studies as a measurement tool. In two previous experiments, researchers used Muse to measure event-related potential [5] and peoples' concentration level during a lecture [6]. In this study, Muse is used to track how participants' gamma waves varied while they completed a test as a function of what type of expectation they were given regarding their performance. The author then examined how the expectation correlated to their final test performance. A detailed hypothesis and the purpose of my study are listed below.

2.3 Hypothesis and purpose

The hypothesis of this study is that when given high-expectation encouragement, participants' confidence and the strength of their gamma waves will increase, which may correlate to a higher test score. In contrast, participants who receive low-expectation discouragement will have less confidence, less intense gamma activity and a lower test score.

This research can hopefully benefit anxious test takers. A previous study demonstrated that lack of self-confidence was the biggest source of test pressure [7]. If families and teachers understand that positive interpersonal expectations can increase students' confidence, they will be more capable of supporting students before tests.

3 Methods

3.1 Participants and groups

Table 1. Demographics

Student demographics	Group A (high expectation)	Group B (low expectation)	Group C (control group)
Atudent age (yrs)	10-11: 3 11-12: 0	10-11: 1 11-12: 2	10-11: 1 11-12: 2
Student gender	Male: 3 Female: 0	Male: 2 Female: 1	Male: 2 Female: 1

Nine fourth-graders (age 10.6-11.8 years old) from a rural school in Guangxi, China were randomly chosen and divided into three groups (group A/B/C). Students in group A received only high-expectation encouragement, students in group B received low-expectation discouragement, and students in group C received no intervention (i.e., the control group). Participants' detailed demographic information is shown in Table 1.

3.2 EEG set up

Participants were first assisted in wearing and calibrating the Muse headband, including ensuring that electric signals could flow naturally to all four electrodes.

3.3 Recording, testing and self-evaluation

After the initial set up, the author started to record participants' brain waves in Muse Direct, a mobile phone application that can visualize and record the brain waves input from the Muse headband. The author gave three non-identical tests (test 1, test 2 and test 3) to participants in random order. Each test contained 32-36 diagrammatic reasoning questions, and participants had three minutes to work on each test. At the end of a test, students estimated their test accuracy as the parameter of confidence. There were three options: they could have made "lots of," "some," or "little (if any)" mistakes in the test. The three choices were converted to predicted accuracy "30%," "60%," and "90%," respectively.

3.4 Deep Residual learning

If the student belonged to high expectation group, they were told the following after the first test: "Even though the testes are hard, never give up. You already have everything you need to solve the problems, and I know you will do well." If the participant belonged to low expectation group, they were told the following: "The testes today are hard. Honestly, you are not going to finish them, and your grades won't be high." If the participant was in control group, nothing was said to them.

After the second test, a stronger statement was spoken to the student that revealed more forceful expectations for the participant. If the participant was in high expectation group, they were told: "I have checked the answers of your past two tests. You did very well. I think you will do even better on the next test." If the participant was in low expectation group, they were told: "I have looked at your past two tests. You made lots of mistakes. The next test is harder, so your grade may be even lower." Nothing was said if the student belonged to control group.

After the third (final) test, the author stopped recording participants' brain waves in Muse Direct and helped students take off the Muse headband, which marked the end of the trial.

3.5 Calculating the strength of gamma waves and percent variance

All brain waves collected in Muse Direct were then sent to MATLAB, a computing program that can analyze raw data of brain waves. With the help from a professional MATLAB programmer, codes were written in MATLAB to calculate the strength of students' gamma waves during the three tests. The percent variance of the strength was computed, which was how much it had changed in comparison with the previous strength measurement. The detailed results are shown below.

4 Results

Each of the nine participants took three tests. Three student participants were given high-expectation comments, three were given low-expectation comments, and three were given none on their test performance.

Results show a correlation between the type of intervention and data collected; that is, a correlation between percent variance of the strength of gamma waves, students' predicted scores and their actual scores.

4.1 Percent variance of the strength of gamma waves

Three groups of students' average gamma waves during each test were calculated, and the percent variance of their average wave strength was computed based on the results of the current test compared with the results of the previous test. Test 1 is the benchmark test, so it is excluded from the chart below. In the second and the third tests, students from group C (the group that received no intervention) and group B (the group that received the low-expectation message) had negative percent variance. In group B, the percent variance was -18% and -12%; in group C, the change was -10% and -3%. However, participants who were given encouragement (group A) had a 130% variance during the third test, which indicated an increase in the strength of their gamma waves.

Figure 1. The percent variance of the strength of participants' gamma waves

4.2 Test information

Though seven out of the nine total students were able to answer at least one more question in the last test than they were in the first test, no significant correlation between the type of given expectation and increased number of answers was observed. There was also no identified relationship between the students' actual test scores and the type of intervention they received.

Nevertheless, some small discoveries about the participants' predicted scores were made, which provided hints for students' confidence level. Students from group B (low expectation) underestimated their scores 83% of the time whereas students from group C (control) and students from group A (high expectation) underrated their performance only 67% and 50% of the time in the second and the third tests. In group B, the total discrepancy between students' underestimation and their actual accuracy in the second and third tests was 144%, which was notably higher than group C's 91% and group A's 48%. As such, students' confidence lowered when given low expectation and increased when given high expectation. Detailed results are shown in table 2 below.

Table 2. Test results

Grouped students		1 st test (without given expectation)		
		Tl	Es	Ac
A (high expectation)	[1]	18	60%	78%
	[2]	13	60%	23%
	[3]	24	90%	67%
	[4]	1	60%	100%
B (low expectation)	[5]	11	60%	45%
	[6]	18	60%	89%
	[7]	20	60%	90%
C (control)	[8]	3	30%	67%
	[9]	11	30%	100%

Grouped students		2 nd test (with given expectation)		
		Tl	Es	Ac
A (high expectation)	[1]	23	60%	78%
	[2]	24	90%	71%
	[3]	18	60%	67%
	[4]	1	30%	100%
B (low expectation)	[5]	19	90%	95%
	[6]	17	60%	59%
	[7]	27	90%	85%
C (control)	[8]	6	60%	100%
	[9]	12	30%	67%

Grouped students		3 rd test (with given expectation)		
		Tl	Es	Ac
A (high expectation)	[1]	16	60%	50%
	[2]	16	60%	50%
	[3]	29	60%	83%
	[4]	2	30%	50%
B (low expectation)	[5]	18	60%	78%
	[6]	22	60%	91%
	[7]	15	60%	80%
C (control)	[8]	11	90%	64%
	[9]	18	90%	94%

Notes: No student received any intervention before the first test because it was the benchmark case. However, different anticipation-related comments were provided before the second and third tests. The 'Tl' column under each test stands for the total number of questions answered by students. The 'Es' column stands for students' estimated scores. The 'Ac' column stands for students' actual scores.

5 Discussion

The percent variance of participants' gamma wave strength illustrated the change in their mental activity. Both low expectation group and control group had negative percent variance in the last two tests, indicating that they had less intense mental activity. In control group, the decreased strength of gamma waves could be explained by the accumulation of fatigue over time. On the other hand, the decline was more pronounced in low expectation group, suggesting that students in group B tried less hard in the tests due to the low-expectation comments they received. Students in group A, who received high-expectation comments, had a very positive percent variance of gamma wave strength in the third test, indicating that they experienced more intense mental activity. This phenomenon suggests that students in group A were motivated by the intervention, so they worked harder when solving the problems.

The lack of correlation between the type of intervention and students' test scores indicates that the expression of expectation had no instant impact on participants' problem-solving abilities. Nevertheless, low expectation group students' underestimation implies that receiving discouragement made them less confident about their performance than they were previously. The further drop of their estimated scores in the third test suggests that when negative expectations were reinforced, students became even more pessimistic about their intellectual ability. In contrast, high expectation group had less tendency to underestimate their performance than low expectation group and control group because the frequency of high expectation group A's underestimation (50% of the time) is the lowest among the three groups. This trend implicates that group A students had increased confidence due to the high-expectation comments. Therefore, it appears that the expressed expectations had an impact on test-takers' self-esteem, and the influence became more pronounced when the intervention was repeated.

6 Conclusion and Future Work

Although the study did not find a relationship between the participants' test scores and the expressed expectation, findings emerged related to students' gamma wave strength and their self-evaluation scores. First, when high-expectation comments were repeated, students' mental activity increased sharply. Second, when given low expectation comments or no intervention, students' mental activity declined. Third, students underestimated their test scores 83% of the time after low-expectation comments were provided, which indicated their decreased confidence. Fourth, students who were given high-expectation comments became more confident and less prone to underestimate their scores. Future researchers should replicate the experiment with a larger participant pool and over a longer period in order to provide stronger evidence for these findings. These findings have considerable potential for educating students, teachers and parents and helping to alleviate pressure students' feel

during tests, so students can flourish both in their academic studies and in life.

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