

# Living with learning difficulties: Two case studies exploring the relationship between emotion and performance in students with learning difficulties

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**Abstract.** Research demonstrates that positive emotions contribute to students' greater engagement with the learning experience, while negative emotions may detract from the learning experience. The purpose of this study is to evaluate the effect of a computer-based training program on the emotional status and its effect on the performance of two students with learning difficulties: a second-grade student of a primary school with Simpson-Golabi-Behmel syndrome and a fourth-grade student of a primary school with learning difficulties. For the purpose of this study, the "BrainHQ" web-based cognitive training software and the mobile app "AffectLecture" were used. The former was used for measuring the affective state of the students before and after each intervention. The latter was used for improving students' cognitive development, in order to evaluate the possible improvement of their initial emotional status after the intervention with "BrainHQ" program, the possible effect of positive/negative emotional status on their performance, as well as the possible effect of high/poor performance on their emotional status. The results of the study demonstrate that there is a positive effect of emotion on performance and vice versa and the positive effect of performance on the emotional status and vice versa. These findings suggest that the affective state of students should be taken into account by educators, scholars and policymakers.

**Keywords:** Learning Difficulties, Cognitive Training, BrainHQ, Emotional Status, AffectLecture, Performance.

## 1 Introduction

Educational policy has traditionally paid attention to the cognitive development of students without focusing on how emotions adjust their psychological state and how

this affects their academic achievement. Emotions have a large influence over mental health, learning and cognitive functions. Students go through various emotional states during the education process [1] thus their mental state is considered to play a major role in obtaining internal motivation [2-4]. Existing research in the field of education has shown however that students' cognitive processes were far more important than emotional processes [5]. Therefore, educational research should take into consideration the experience of people with disabilities, including those with learning difficulties [6].

The definition of 'learning difficulties' (LD) is commonly used to describe students with intellectual/learning disabilities. For further specification, this group may be considered as a sub-group of all those students who face several disabilities such as physical, sensory, and emotional-behavioral difficulties, as well as learning difficulties [7].

Learning difficulties are considered to be a developmental disorder that occurs more frequently in school years. It is commonly recognized as a "special" difficulty in writing, reading, spelling and mathematics affecting approximately 15% to 30% of students total [8]. The first signs of the disorder are most frequently diagnosed from preschool age, either within the variety of speech disorders or within the variety of visual disturbances.

Students with learning difficulties (LD) within the middle school years typically display slow and effortful performance of basic academic reading and arithmetic skills. This lack of ability in reading and calculating indicates incompetence in cognitive processes that have far-reaching connotations across learning, teaching, and affective domains [9].

When it comes to obtaining certain academic skills, the majority of students with LD during their middle school years achieve fewer benefits in learning and classroom performance. Therefore, it's inevitable the fact that as the time goes by, the gap becomes wider year after year and their intellectual achievements are considered to be less than the ones made by their peers [10-12]. In addition to deficiencies in basic academic skills, many students with LD in the middle years of schooling may even have particular cognitive characteristics that slow the process of their learning, like reduced working memory capacity and also the use of unproductive procedures for managing the components of working memory. In conclusion, learners with LD require a more sufficient way of academic instruction [13].

Simpson-Golabi-Behmel syndrome (SGBS) is a rare, sex-linked (X) disorder with prenatal and postnatal overgrowth, physical development and multiple congenital abnormalities. The primary reference to the disorder was made by Simpson et al. [14]. The phenotype of the syndrome broad and includes typical countenance, macroglossia, organomegaly, Nephrolepis, herniation, broad arms and legs, skeletal abnormalities, supraventricular neck, conjunctivitis, more than two nipples and constructional dysfunctions [15]. In line with Neri et al. [16], men have an early mortality rate and an expanded possibility of developing neoplasms from fetal age. Women are asymptomatic carriers of the gene, who frequently present coarse external features in the face and mental incapacity [17].

The psychomotor development of patients with SGBS is diverse and ranges from normal intelligence to moderate and severe disorder that may be appeared at birth [18-20]. Speech delay occurs in 50% of cases and motor delay in 36% [18].

Moreover, speech difficulties were appeared in most affected people, which are partially justified by macroglossia and cleft lip or palate. Affected boys show mild cognitive disorders that are not always related to speech delay and walking. Moreover, they face difficulty in fine and gross motor development [20].

Learning difficulties are frequently related to behavioral problems and ambiguities, attention deficit disorder, hyperactivity, concentration and writing disorders [21]. However, there has been limited research about the behavioral phenotype and the problematic behavior that progress during puberty, as well as the behavioral difficulties during the school years, which need mental health support and therapy [22].

There is a wide range of syndrome characteristics, which have not been identified or examined yet. Every new case being studied, found not to have precisely the same characteristics as the previous one. As new cases of SGBS appear, the clinical picture of the syndrome is consistently expanding [23].

### **1.1 Related work and background**

Research has shown that children's and youngsters' emotions are associated with their school performance. Typically, positive emotions such as enjoyment of learning present positive relations with performance, while negative emotions such as test anxiety show negative relations [24-26].

Related work in the field of education, has indicated that students' learning is related to their emotional state. Thus, negative emotions decrease academic performance, while positive emotions increase it [27, 28]. However, recent studies have been based on specific emotions, disregarding the possible presence of other emotions that may have a significant impact on motivation and/or school performance [29].

At this same educational level, Yeager et al. [30] investigated the possible negative correlation between boredom and math activities, while Na [31] observed a negative correlation between anxiety and English learning. Likewise, Pulido and Herrera [32] carried out a study with primary, secondary and university students which revealed that high levels of fear predict low academic performance, irrespective of the school subject.

In addition, Trigueros, Aguilar-Parra, Cangas, López-Liria and Álvarez [33] in their study with adolescents indicated that shame is negatively related to motivation, which negatively adversely impacts learning and therefore academic performance. Moreover, Siouli et. al. carried out a study with primary students which showed that emotion influences academic performance in all class subjects and that the teaching process can induce an emotional change over a school week [34]. The results of the aforementioned studies confirm a strong relationship between academic performance and students' emotional state.

Several research studies have examined the relationship between emotions and school performance. For students with syndromes and learning difficulties, however, the only data that occur from our case studies.

## **2 Methods**

### **2.1 Cognitive training intervention**

The Integrated Healthcare System Long Lasting Memories Care-LLM Care [35] was exploited in this study, as an ICT platform that combines cognitive exercises (BrainHQ) with physical activity (wFitForAll). LLM Care was initially exploited in order to offer the important training for enhancing the elderly's cognitive and physical condition of their health [36], as well as the quality of life and autonomy of vulnerable people [37].

BrainHQ [38], as the cognitive component of LLM Care, it is a web-based training software developed by Posit Science. It is the sole software available in Greek being used to any portable computing device (tablet, cell phone, etc.) as an application either on Android or on IOS provided in various languages. Unquestionably, enhancement of brain performance can lead to multiple benefits to everyday life. Both research studies and the testimonials of users themselves show that BrainHQ offers benefits in enhancing thinking, memory and hearing, attention and vision, improving reaction speed, safer driving, self-confidence, quality discussion and good mood. BrainHQ includes 29 exercises divided into 6 categories: Attention, Speed, Memory, Skills, Intelligence and Navigation [38].

Students' training intervention attempts to fill some of the identified gaps in research and practice concerning elementary school students with learning difficulties and syndromes. Specifically, it aims to produce an intensive intervention to provide students with the required skills in order to engage them more successfully with classroom instruction. This intervention was designed as a relatively long-term, yet cost-effective, program for students with poor performance in elementary school.

BrainHQ software has therefore been used as an effort to cognitively train students with genetic syndromes and complex medical cases with psychiatric problems that go beyond cognitive function [39-40]. An intervention using BrainHQ could be a promising approach for individuals with Simpson-Golabi-Behmel and individuals with Learning Difficulties.

### **2.2 The AffectLecture App**

AffectLecture application (courtesy of the Laboratory of Medical Physics AUTH: accessible for download through the Google Play market place) was utilized to measure the students' emotional status. It is a self-reporting, emotions-registering tool and it consists of a five-level Likert scale measuring a person's emotional status ranging from 1 (very sad) to 5 (very happy) [41].

### **2.3 Participants**

I.M. (Participant A) is an 8-year-old student with Simpson-Golabi-Behmel Syndrome, who completed the second grade of Elementary School in a rural area of Greece and S.D. (Participant B) is a 10-year-old student with Learning Difficulties who completed the fourth grade of Elementary School in a provincial area in Greece.

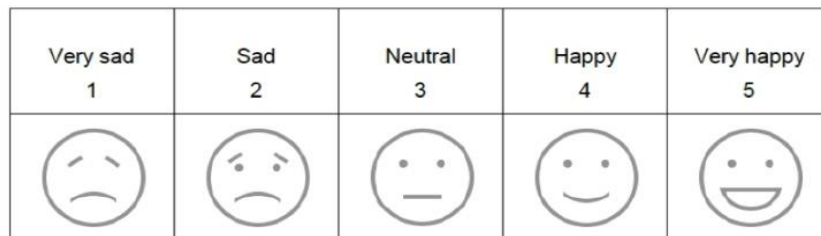
Participant A performed a 30-session cognitive training intervention applied during school time (3-4 sessions/week for 45 minutes each). Few interventions were also

conducted at the student's house in order to complete the cognitive intervention program.

Participant B attended a 40-session training intervention at school during school time and at the student's house (3 sessions/week for 45 minutes each for 8 weeks and then everyday sessions for the last two weeks of the interventions).

The cognitive training interventions were performed in classrooms, meaning that both students were in their own school environments and they received an equivalent cognitive training, although they faced different learning difficulties

Prior to the beginning of this study, both students were informed about the use of AffectLecture app by exploiting their tablets, in which the app was installed. The students' were urged to state how they felt by selecting an emoticon. The emotional status was being measured before the start and by the end of each training intervention, for the entire duration of the training sessions. In Fig. 1 the students had to choose between five emoticons and select the one that best expressed them at that moment.



**Fig. 1.** AffectLecture Input

Teachers provided at the beginning of each training intervention a unique 4-digit PIN, which let the students have access to the session and vote before and after it, so they could state their emotional status.

## 2.4 Research Hypotheses

Hypothesis 1: Students' positive emotional state will have a positive effect on their performance, while students' negative emotional state will have a negative effect on their performance.

Hypothesis 2: High students' performance will have a positive effect on their emotional status, while poor students' performance will have a negative effect on their emotional status.

## 2.5 Data collection methods

Students' performance was assessed by the online interactive BrainHQ program. The detailed session results of BrainHQ and the students' emotional status as measured by the AffectLecture app before and after each intervention were used in order to collect crucial data for the purpose of the study.

## 2.6 Data collection procedure

Before the beginning of the study, students were informed about the use of BrainHQ and the AffectLecture app, and they were instructed to have their tablets with them. The AffectLecture app was installed in both students' devices. Accommodated test scores in 6 categories (Attention, Speed, Memory, Skills, Intelligence and Navigation cognitive performance) were being measured by BrainHQ interactive program. During each session students were trained equally in all six categories starting with Attention and moving on to Memory, Brain Speed, People Skills, Intelligence, and Navigation in order to benefit the most. Training time was equally spaced. Each time students completed an exercise level, they earned "Stars" according to their performance and progress in order to understand how their brain is performing and improving. The students' emotional status was being measured before the beginning and by the end of each cognitive training session, throughout the intervention period.

## 2.7 Evaluation methodology

A non-parametric Wilcoxon Signed-rank test was conducted to compare within interventions' differences in emotional status. The AffectLecture responses of each student, before and after every intervention with BrainHQ cognitive training interactive program, were used for this comparison. Following that, a Spearman rank test was conducted to discover the relation between performance and emotional status variables. The significance threshold was set to 0.01 for all tests.

## 3 Results

Concerning intervention results revealed a statistically significant difference in the emotional status before and after the intervention for participant A (Wilcoxon  $Z = -3.000$ ,  $p = 0.003 < 0.01$ ), as well as for participant B (Wilcoxon  $Z = -3.382$ ,  $p = 0.001 < 0.01$ ) as shown in Table 1.

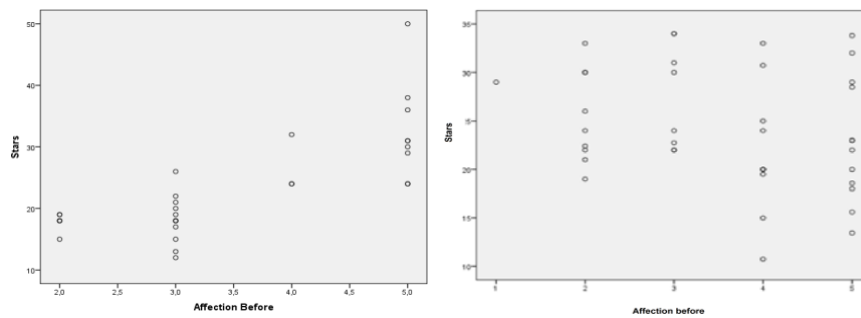
**Table 1.** Within interventions comparisons.

<b>Participants</b>	<b>Total no of interventions</b>	<b>Z</b>	<b>p-value</b>
Participant A	30	-3.000	.003
Participant B	40	-3.382	.001

Furthermore, correlation coefficient Spearman Rho was used to measure the intensity of the relationship between the performance indicator provided by cognitive training program BrainHQ (stars) and the emotional status of participant A and participant B. As hypothesized, the performance may have a correlation with the affective state of the students.

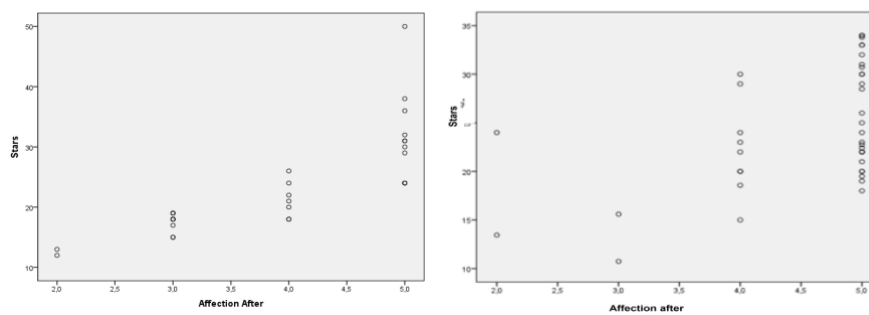
The scatter diagrams (see Fig. 2) suggest a strong positive correlation between emotional status before the intervention and performance (BrainHQ stars) for participant A (Spearman rho  $r = 0.77$ ,  $p = 0.000 < 0.01$ ), as well as for participant B (Spearman rho  $r = -0.255$ ,  $p = 0.112 > 0.01$ ). Following the 0.01 criteria, the

interpretation of the results shows that positive emotional status before the intervention tends to increase students' performance during the cognitive training. More specifically, these findings illustrate the importance of positive emotions in the performance and other outcomes in relation with achievement, meaning that cognitive training intervention positively influenced students' experiences in the level of performance.



**Fig. 2.** Scatter Diagrams for emotional status before the intervention and performance in BrainHQ cognitive training interactive program for Participant A and B.

The scatter diagrams (see Fig. 3) also suggest a strong positive correlation between performance (BrainHQ stars) and emotional status for participant A (Spearman rho  $r = 0.896$ ,  $p = 0.000 < 0.01$ ), as well as for participant B (Spearman rho  $r = 0.433$ ,  $p = 0.005 < 0.01$ ). Following the 0.01 criteria, the interpretation of the results show that high performance during interventions tends to increase students' emotional status after the cognitive training. Data on positive and negative emotions were obtained by asking each student to report their final emotional status on AffectLecture. An increase in happiness and motivation, was also observed when students' performance was increased, while totally different emotions were expressed and signs of demotivation were observed when students' performance was poor. These findings identify the impact of general well-being and happiness on performance.



**Fig. 3.** Scatter Diagrams for emotional status after the intervention and performance in BrainHQ cognitive training interactive program for Participant A and B.

The correlation values coefficients (between emotional status before/after the intervention and performance) and their corresponding p- are included in Tables 2 and 3.

**Table 2.** Correlations between affection and performance for participant A.

<b>Participant A</b>	<b>Total no of interventions</b>	<b>Spearman Cor. Coef.</b>	<b>p-value</b>
Affection before the intervention / Performance (Stars)	30	.77	.000
Performance (Stars)/ Affection after the intervention	30	.896	.000

**Table 3.** Correlations between affection and performance for participant B.

<b>Participant B</b>	<b>Total no of interventions</b>	<b>Spearman Cor. Coef.</b>	<b>p-value</b>
Affection before the intervention / Performance (Stars)	40	-.255	.112
Performance (Stars)/ Affection after the intervention	40	.433	.005

## 4 Discussion

The present study was designed to investigate the influence of emotional state on students' performance, as well as to identify the relations between cognitive performance and emotion. Specifically, the affective state of two elementary school students with learning difficulties was measured for long periods of time, by the AffectLecture app, before and after intervention with BrainHQ. Additionally, cognitive performance was measured by the online interactive BrainHQ program at the end of each session.

As hypothesized students' positive emotional state had a positive effect on their performance. By contrast, students' negative emotional state had a negative effect on their performance. It can be also concluded that high students' performance had a positive effect on their emotional status, while poor students' performance had a negative effect on their emotional status. Repeated measures revealed a significant positive effect of emotion on performance and vice versa and a positive effect of performance on emotional status and vice versa.

The results imply that performance influences students' emotions, suggesting that successful performance attainment and positive feedback can develop positive



emotions, while failure can escalate negative emotions. This set of case studies adds to the small body of empirical data regarding the importance of emotions in children with learning difficulties and syndromes.

The findings are in agreement with previous studies reporting that achievement emotions can profoundly affect students' learning and performance. Positive activating emotions can positively affect academic performance under most conditions. Conversely, negative deactivating emotions are posited to uniformly reduce motivation implying negative effects on performance [42-46]. Numerous research studies have explored the relationship between emotional state and academic achievement. However, for pupils with Simpson Golabi Behmel syndrome and learning difficulties, the only available data comes from our case studies.

The findings of this research in sequence with BrainHQ available data (collected stars) reveal the significant contribution of the online brain training program (BrainHQ) to the cognitive enhancement of both students. The results from cognitive exercises and assessments in addition to students' daily observation indicate that intervention with the BrainHQ program had a positive impact on cognitive function mainly in the area of visual/working memory and the capacity to retrieve and process new information, processing speed affecting daily life activities, attention, and concentration. Besides that, cognitive training improved students' performance in solving learning problems and in the area of Memory, Speed, Attention, Skills, Navigation, and Intelligence [47].

At this point it is important to identify possible limitations of the present study design. The measurements that were performed cannot cover the total range of affecting factors that possibly impact participants' cognitive performance and emotional state. Some of those factors, which were not included, could be: the level of intellectual disability/difficulty, language proficiency, family's socioeconomic background, living conditions, intelligence, skills, and learning style.

The limitations of this study also consist of the research method (case study) that has often been criticized for its lack of scientific generalizability. For this reason the results of this study must be treated with caution and contain bias toward verification. Larger-scale studies should be conducted to prove the effect of emotional state on the cognitive function of children with learning difficulties/disabilities. On the other hand, case study research provides great strength in investigating units consisting of multiple variables of importance and it allows researchers to retain a holistic view of real-life events, such as behavior and school performance [48].

At this point, we should take into account that students tend to present their emotions as 'more socially acknowledged' when they are being assessed. Furthering this thought consideration must be given as to whether students consequently and intentionally modified their emotions and behaviours due to the presence of an observer, introducing further bias to the study.

Moreover, the knowledge of being observed can modify emotions and behaviour. Such reactivity to being watched is sometimes referred to as the "Hawthorne Effect". The Hawthorne Effect refers to a phenomenon in which people alter their behaviour as a result of being studied or observed [49]. They attempt to change or improve their behaviour simply because it is being evaluated or studied. The Hawthorne Effect is the intrinsic bias that must be taken into consideration when studying findings.

## 5 Conclusions

The current study provides evidences that learning difficulties can be ameliorated by intensive adaptive training and positive emotional states. The results of a strong positive correlation between affective state and cognitive performance on BrainHQ indicate that the better the affective state of the student, the higher the performance, which was the hypothesis set by the authors. However, the causal direction of this relationship requires further investigation by future studies.

Developing and sustaining an educational environment, which celebrates the diversity of all learners, is circumscribed by the particular political-social environment, as well as the capacity of school communities and individual teachers to confidently embed inclusive attitudes and practice into their everyday actions. In addition, identifying and accounting for the various dynamics which influence and impact the implementation of inclusive practice, is fundamentally bound to the diversity or disability encountered in the classroom.

At the same time, it would be useful and promising to perform further research over a long period of time to investigate the influence of positive, neutral and negative affective states on students' with cognitive and learning difficulties performance. Also, the findings could have significant implications understanding the effect of positive or negative emotions on cognitive function and learning deficits of children with learning disabilities. These findings obtained from the children after adaptive training suggest that positive emotional status during computer cognitive training may indeed enhance and stimulate cognitive performance with generalized benefits in a wide range of activities. It is essential, that this research continues throughout the school years of both students to evaluate the learning benefits.

Ultimately, more research on the relation between emotion and performance is needed for better understanding students' emotions and their relations with important school outcomes. Social and emotional skills are key components of the educational process to sustain students' developmental process and conduct an effective instruction. These findings may also suggest guidelines for optimizing cognitive learning by strengthening students' positive emotions and minimizing negative emotions and the need to be taken into consideration by educators, parents and school psychologists.

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