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# Relationship Between Brain-Derived Neurotrophic Factor (BDNF) and Multiple Intelligence Profiles

**Süheyb Okur[1]*, Bülent Bayraktar[2]**

[1*]Dr., Department of Religious Psychology, Faculty of Theology, Bayburt University, 69000, Bayburt, Türkiye, E-mail: suheybokur@bayburt.edu.tr, Phone: *+90536 452 04 06*, ORCID: 0000-0002-0242-5921
[2]Associate Prof., Bayburt University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Bayburt, Türkiye, E-mail: bulentbayraktar@bayburt.edu.tr, ORCID: 0000-0002-2335-9089

***Corresponding author.** Süheyb OKUR
***Dr.**, *Bayburt University Faculty of Theology, Department of Religious Psychology Full postal address: Bayburt University Faculty of Theology, Department of Religious Psychology, 69000 Bayburt, Türkiye, Email: suheybokur@bayburt.edu.tr, m Phone: +90536 452 04 06*

**Abstract**
**Background:** The aim of this study is to investigate the relationship between salivary Brain-Derived Neurotrophic Factor (BDNF) levels and multiple intelligence profiles of university students.
**Methods:** This research is a cross-sectional study conducted on university students studying in Turkey using the relational screening method. 100 volunteers, 50 female and 50 male, aged between 18-30, studying in the city of Bayburt participated in the study and the participants were selected through voluntary participation. Multiple Intelligence Scale was used to determine the participants' strengths and weaknesses in different intelligence areas. Saliva samples were also taken to evaluate their cognitive functions and BDNF levels were examined. Descriptive statistics, independent sample t-test and Pearson correlation tests were used in data evaluation and the significance level ($p < .05$) was accepted for all statistical results.
**Results:** The study results indicated no statistically significant relationship between salivary BDNF levels and the total score on the Multiple Intelligence Profile Scale ($p > .05$). However, it was determined that BDNF levels had weak, negative, and significant correlations with the sub-dimensions of spatial intelligence ($r = -.198$, $p = .049$), intrapersonal intelligence ($r = -.200$, $p = .046$), and environmental intelligence ($r = -.219$, $p = .028$). In gender comparisons, female participants' total scores on the Multiple Intelligence Profile Scale were found to be significantly higher than those of males ($p = .002$). When examining the sub-dimensions, it was determined that females' scores for musical ($p = .019$), spatial ($p = .042$), bodily-kinesthetic ($p < .001$), intrapersonal ($p = .011$), and environmental intelligence ($p = .001$) were significantly higher than those of males. Conversely, no significant difference was detected between genders in BDNF levels ($p > .05$). As expected, positive and highly significant correlations were found between the Multiple Intelligence Profile Scale total score and all its sub-dimensions ($p = .000$).
**Conclusions:** This study has revealed that university students' salivary BDNF levels do not exhibit a strong linear relationship with their general multiple intelligence profile. However, the identified weak and inverse connections between BDNF and specific intelligence domains such as spatial, intrapersonal, and environmental intelligence suggest that BDNF's role in different cognitive areas might be more specific and potentially complex, rather than providing general cognitive support. This implies that BDNF's interaction with cognitive functions may not always be as general and positively oriented as commonly assumed, but could differentiate according to the type of intelligence and the context. On the other hand, the significant differences observed in favor of females in certain multiple intelligence areas once again underscore the importance of considering individual competencies and potential gender-related tendencies in educational approaches.

**Keywords:** Brain-Derived Neurotrophic Factor (BDNF), Multiple Intelligence Profile, University Students, Salivary BDNF, Gender Differences

## Backround

Intelligence is defined as the cognitive ability of individuals to adapt to their environment, solve problems, learn, and think abstractly, and has played a vital role in the progress of humanity and the development of civilizations throughout human history. Today, the globalizing world, technological developments, and complex problems increase the importance of intelligence even more (Sternberg, 2019). Intelligence is a capacity that predicts individuals' academic success and general success in life (Mandelman et al., 2016).

Howard Gardner, a developmental psychologist and neuropsychologist, noticed the inadequacies of the traditional understanding of intelligence during his studies. It was reported that intelligence consists of multiple abilities specialized in different areas rather than a single general ability (Gardner, 2011).

Howard Gardner developed the Theory of Multiple Intelligences in 1983. This theory is an approach that challenges the traditional understanding of intelligence and defines intelligence as a set of multiple abilities that can develop in different areas rather than a single general ability (Gardner, 2011). Each type of intelligence expresses an individual's capacity to learn, solve problems and produce products in certain areas (Gardner, 1999). Gardner's innovative perspective on the concept of intelligence has been an important turning point in the fields of psychology and education. This approach has pioneered the adoption of more inclusive and individualized approaches in education by emphasizing the fact that individuals have different learning styles, strengths and interests (Chen & Gardner, 2005). The reflections of the theory in education have emphasized the importance of student-centered approaches and revealed that teaching strategies should be diversified. Teaching methods that appeal to different types of intelligence have allowed students to discover their own strengths and participate more actively in the learning process (Visser et al., 2006). However, there are also debates about the scientific validity and practical applications of the theory of multiple intelligences. The most important of these debates are how independent types of intelligence are from each other, how these types of intelligence can be measured, and the effectiveness of educational practices based on the theory of multiple intelligences (Waterhouse, 2006). In this study, the multiple intelligence levels of the participants were measured using the Multiple Intelligence Profiling Questionnaire (MIPQ).

Brain-derived neurotrophic factor (BDNF) is a neurotrophin that affects the survival, growth and functions of neurons in the central and peripheral nervous system, provides stabilization of synapses, and regulates synaptic function, axon and dendrite branching (Duman and Monteggia, 2006; Bayraktar, 2019). BDNF, a neurotrophic factor with a molecular weight of approximately 13.5 kDa and belonging to the neurotrophin family, plays a critical role in the development, health and functions of the nervous system (Bayraktar, 2020; Gliwińska et al., 2023). The hippocampus is involved in the control of learning and memory and the regulation of the hypothalamic-pituitary-adrenal (HPA) axis. It also has connections to the amygdala and prefrontal cortex, regions more directly involved in emotion and cognition and therefore contributing to other important symptoms of depression (Duman and Monteggia, 2006). BDNF is found in large amounts in the hippocampus, cortex, and basal forebrain, and has a physiological role in memory, learning, and higher cognitive functions (Murer et al., 2001; Bayraktar, 2019). Deficiency or dysfunction of BDNF is associated with learning difficulties, memory problems and cognitive decline (Zuccato & Cattaneo, 2009).

In the literature review, no study examining the relationship between multiple intelligences and BDNF was encountered. This situation significantly enhances the originality of the current research and its potential contribution to the field. Investigating the possible interaction between Multiple Intelligences Theory, which aims to assess individuals' diverse abilities and potentials more comprehensively by moving beyond traditional intelligence measures, and BDNF, a fundamental molecular regulator of brain plasticity and cognitive functions, could open new horizons for both educational sciences and neuroscience. Specifically, understanding how different intelligence profiles exhibit patterns with BDNF levels may shed light on the biological underpinnings of individual differences and could lay the groundwork for the future development of personalized educational strategies or cognitive support programs. In this context, the present study aimed to examine the relationship between mean salivary BDNF levels according to multiple intelligence profiles with respect to certain variables. The findings of this research have the potential to make a significant contribution to the literature by bridging the gap between these two important concepts and may guide future studies in this field.

## Methods

### Participants and Procedures

The sample for this research comprised 100 volunteer university students from Bayburt University, Faculty of Theology, with an age range of 18 to 30 years. The participants reported no known health problems and exhibited an equal gender distribution (50 female and 50 male). For study inclusion, 100 students were assessed for eligibility; none of the assessed students met the exclusion criteria or declined to participate. Consequently, the targeted sample size was achieved, and data obtained from all participants were included in the analyses. The sample size was calculated as 100 individuals using the G*Power 3.1.9.7 analysis program, considering a 95% confidence interval, a 5% margin of error, and 80% statistical power. Prior to commencing the research, necessary ethical approval was obtained from the Bayburt University Research Ethics Committee (2025/Decision no: 119). In accordance with the principles of the Helsinki Declaration, participants were provided with detailed information about the study, and their written consent was obtained through the signing of an 'Informed Volunteer Consent Form'. Participation in the study was entirely voluntary. CREB and cortisol hormone levels of the participants.

**The Collection of Research Data:** Data were collected face to face in an average of 15 minutes

using a general information form for university students and the Multiple Intelligence Profile Scale. Saliva samples were taken to determine the participants' salivary BDNF levels.

**Collection of Saliva Samples:** Saliva samples were collected from the participants between 08:00 and 09:00 in the morning using the passive drool method into Salivette® tubes (Sarstedt, GERMANY), collecting a volume of 5 mL. In the laboratory, after being centrifuged at 2000 g for 20 minutes in a refrigerated centrifuge (NF 1200R, NUVE, Ankara, TURKEY), the saliva samples were stored at -80°C until analysis for BDNF levels.

**Measurement of Salivary BDNF Levels:** In the study, Human BDNF ELISA Kit (BT LAB, Cat. No E1302Hu, CHINA) was used to measure the amounts of BDNF in saliva samples. The ELISA kit determined the concentrations ranging from 31.25 to 2000 pg/mL. The intra-assay coefficients were 8.0% and the inter-assay coefficients were 10.0%. The ELISA kit was studied in accordance with the procedure specified in the manufacturer's catalog, using the human-specific.

**The Multiple Intelligence Profile Scale:** Çelik et al. (2024) adapted the "Multiple Intelligences Profiling Questionnaire" into Turkish. This questionnaire was originally developed by Tirri and Komulainen (2002) based on Gardner's (1999) Theory of Multiple Intelligences and subsequently revised by Tirri and Nokelainen (2011). The scale employs a 5-point Likert-type rating system, with response options ranging from 1 (Strongly Disagree), 2 (Disagree), 3 (Undecided), 4 (Agree), to 5 (Strongly Agree). Comprising 23 items and 9 factors, the scale has a structure that explains 74.67% of the total variance. Cronbach's alpha value of our sample was .857.

**Statistical analysis:**

Statistical analyses were performed using SPSS (Statistical Package for the Social Sciences) version 26.0 software. Numerical data are presented as mean ± standard deviation (SD). Following normality testing, which indicated a normal distribution of the data, an independent samples t-test was utilized. The analysis of correlations between numerical variables was conducted using Pearson's correlation test. All analyses were performed with a 95% confidence interval, and a p-value of less than 0.05 was considered statistically significant.

## Results

**Table 1 Descriptive Statistics**

| Value | Min. | Maks. | $\bar{X}$ | sd | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| BDNF (ng/ml) | 1.03 | 9.01 | 5.571 | 2.434 | .090 | -1.382 |
| The Multiple Intelligence Profile Scale Total | 49.00 | 106.00 | 80.42 | 12.813 | -.018 | -.556 |
| Linguistic Intelligence | 2.00 | 10.00 | 6.460 | 1.805 | -.223 | -.203 |
| Logical-Mathematical Intelligence | 3.00 | 15.00 | 8.940 | 2.415 | .247 | .061 |
| Musical Intelligence | 4.00 | 20.00 | 12.33 | 3.739 | .131 | -.190 |
| Spatial Intelligence | 2.00 | 10.00 | 6.630 | 1.920 | -.521 | .030 |
| Bodily-Kinesthetic Intelligence | 3.00 | 10.00 | 7.250 | 1.908 | -.304 | -.558 |
| Interpersonal Intelligence | 3.00 | 10.00 | 7.510 | 1.684 | -.367 | -.273 |
| Intrapersonal Intelligence | 4.00 | 15.00 | 11.01 | 2.587 | -.367 | -.273 |
| Spiritual Intelligence | 2.00 | 10.00 | 7.630 | 1.801 | -.602 | -.102 |
| Environmental Intelligence | 8.00 | 15.00 | 12.66 | 2.184 | -.621 | -.584 |

* BDNF: Brain Derived Neurotrophic Factor

Table 1 presents the mean, standard deviation, minimum-maximum, and skewness-kurtosis values for the BDNF and multiple intelligence scale and its sub-dimensions. It is observed that the skewness and kurtosis values fall within the acceptable limits of -2 to +2. This indicates that the distributions of the analyzed variables are normal. Accordingly, parametric tests were used in the analysis of the data.

The mean salivary BDNF level obtained from participants was calculated as ($\bar{X}$) = 5.571. Examination of the minimum and maximum values (1.03 - 9.01) indicates that the distribution spans a wide range. The standard deviation ($\bar{X}$) = 2.434) demonstrates the extent of dispersion of BDNF levels around the mean. The magnitude of the standard deviation relative to the mean suggests considerable inter-individual variability in BDNF levels. Regarding the Multiple Intelligence Profile Scale total score, the distribution was observed to range from 49.00 to 106.00, with a mean of 80.42. Considering that the theoretical scores obtainable from the scale range between 23 and 115, the observed range encompasses a significant portion of this theoretical range. This indicates diversity in the general multiple intelligence profiles of the participants and suggests that they possess a multiple intelligence profile that is above moderate

and approaching high. For the sub-dimensions of the scale, the following means were obtained: Linguistic Intelligence ($\bar{X}$) = 6.460, Logical-Mathematical Intelligence ($\bar{X}$) = 8.940, Musical Intelligence ($\bar{X}$) = 12.33, Spatial Intelligence ($\bar{X}$) = 6.630, Bodily-Kinesthetic Intelligence ($\bar{X}$) = 7.250, Interpersonal Intelligence ($\bar{X}$) = 7.510, Intrapersonal Intelligence ($\bar{X}$) = 11.01, Spiritual Intelligence ($\bar{X}$) = 7.630, and Environmental Intelligence ($\bar{X}$) = 12.66.

These data indicate that the results show a balanced distribution. When different intelligence types are examined individually, participants perceived themselves as more competent particularly in the areas of Environmental Intelligence and Spiritual Intelligence, while their average scores in Logical-Mathematical Intelligence were somewhat lower compared to others. Furthermore, it was determined that Musical Intelligence scores exhibited the most variation, whereas Interpersonal Intelligence scores were the most homogenous among participants.

**Table 2: Comparison of data by gender (Independent Sample T-Test)**

| Value | Gender | N | $\bar{X}$ | sd | t | p |
|---|---|---|---|---|---|---|
| BDNF (ng/ml) | Female | 50 | 5,2918 | 2,4610 | -1.149 | .253 |
| | Male | 50 | 5,8503 | 2,3995 | | |
| The Multiple Intelligence Profile Scale Total | Female | 50 | 84,320 | 12,751 | 3.181 | **.002*** |
| | Male | 50 | 76,520 | 11,751 | | |
| Linguistic Intelligence | Female | 50 | 6,620 | 1,861 | .885 | .378 |
| | Male | 50 | 6,300 | 1,752 | | |
| Logical-Mathematical Intelligence | Female | 50 | 8,900 | 2,168 | -.165 | .869 |
| | Male | 50 | 8,980 | 2,661 | | |
| Musical Intelligence | Female | 50 | 13,200 | 3,730 | 2.381 | **.019*** |
| | Male | 50 | 11,400 | 3,575 | | |
| Spatial Intelligence | Female | 50 | 7,020 | 1,778 | 2.063 | **.042*** |
| | Male | 50 | 6,240 | 1,995 | | |
| Bodily-Kinesthetic Intelligence | Female | 50 | 8,020 | 1,755 | 4.390 | **.000*** |
| | Male | 50 | 6,480 | 1,752 | | |
| Interpersonal Intelligence | Female | 50 | 7,600 | 1,873 | .532 | .596 |
| | Male | 50 | 7,420 | 1,485 | | |
| Intrapersonal Intelligence | Female | 50 | 11,660 | 2,615 | 2.583 | **.011*** |
| | Male | 50 | 10,360 | 2,413 | | |
| Spiritual Intelligence | Female | 50 | 7,900 | 1,908 | 1.508 | .135 |
| | Male | 50 | 7,360 | 1,663 | | |
| Environmental Intelligence | Female | 50 | 13,400 | 1,795 | 3.584 | **.001*** |
| | Male | 50 | 11,920 | 2,302 | | |

* BDNF: Brain Derived Neurotrophic Factor

Table 2 examines whether there is a statistically significant difference between female (N=50) and male (N=50) participants concerning their mean scores ($\bar{X}$) on BDNF, total multiple intelligence scores, and the 9 sub-dimensions of this scale. In this study, Brain-Derived Neurotrophic Factor (BDNF) levels and Multiple Intelligence Profile Scale scores of a total of 100 participants (50 female and 50 male) were compared by gender using an independent samples t-test. According to the analysis results, no significant difference was found in BDNF levels (female $\bar{X}$ = 5.29, male $\bar{X}$ = 5.85; p=.253) (p>.05). On the other hand, the mean total score on the Multiple Intelligence Profile Scale for females ($\bar{X}$ = 84.320) was found to be statistically significantly higher than that of males ($\bar{X}$ = 76.520) (t=3.181, p=.002). While the general multiple intelligence level of females was close to the upper limit of the "moderate level," the multiple intelligence levels of males were at the "moderate level." This statistically significant difference between the two groups (p=.002) may indicate that, within this specific sample, females exhibit a higher tendency in general multiple intelligence potential compared to males.

Upon detailed examination of the scale's sub-dimensions, it was determined that females achieved significantly higher scores than males in five areas: Musical intelligence (female $\bar{X}$=13.200, male $\bar{X}$=11.400; p=.019), Spatial intelligence (female $\bar{X}$=7.020, male $\bar{X}$=6.240; p=.042), Bodily-Kinesthetic intelligence (female $\bar{X}$=8.020, male $\bar{X}$=6.480; p<.001), Intrapersonal intelligence (female $\bar{X}$=11.660, male $\bar{X}$=10.360; p=.011), and Environmental intelligence (female $\bar{X}$=13.400, male $\bar{X}$=11.920; p=.001). When

interpreted according to item means, females had "high level" scores in Bodily-Kinesthetic, Intrapersonal, and Environmental intelligence, whereas males generally showed scores at the "moderate" level or near the lower limits of the "high" level in these and other areas; for instance, males remained at the "moderate level" in Bodily-Kinesthetic and Intrapersonal intelligence. Conversely, no statistically significant difference was observed between genders in terms of scores for Linguistic intelligence (female $\bar{X}$=6.62, male $\bar{X}$=6.30; p=.378), Logical-Mathematical intelligence (female $\bar{X}$=8.90, male $\bar{X}$=8.98; p=.869), Interpersonal intelligence (female $\bar{X}$=7.60, male $\bar{X}$=7.42; p=.596), and Spiritual intelligence (female $\bar{X}$=7.90, male $\bar{X}$=7.36; p=.135). These findings reveal that, in the sample studied, females exhibited a higher tendency in certain multiple intelligence domains compared to males, but there was no distinct gender difference regarding some intelligence types and BDNF levels.

**Table 3: Relationships between Participants' Salivary BDNF, the Multiple Intelligence Profile Scale and its Sub-Dimensions (Correlation Analysis)**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BDNF (ng/ml) | r | 1 | | | | | | | | | |
| | p | | | | | | | | | | |
| | N | 100 | | | | | | | | | |
| The Multiple I. P. S. T. | r | -0,188 | | | | | | | | | |
| | p | 0,062 | | | | | | | | | |
| | N | 100 | | | | | | | | | |
| Linguistic I. | r | -0,154 | ,611** | | | | | | | | |
| | p | 0,127 | 0 | | | | | | | | |
| | N | 100 | 100 | | | | | | | | |
| Logical-Mathematical Intelligence | r | 0,017 | ,421** | ,326** | | | | | | | |
| | p | 0,864 | 0 | 0,001 | | | | | | | |
| | N | 100 | 100 | 100 | | | | | | | |
| Musical I. | r | -0,117 | ,739** | ,335** | ,457** | | | | | | |
| | p | 0,247 | 0 | 0,001 | 0 | | | | | | |
| | N | 100 | 100 | 100 | 100 | | | | | | |
| Spatial I. | r | -,198* | ,710** | ,347** | 0,037 | ,398** | | | | | |
| | p | 0,049 | 0 | 0 | 0,718 | 0 | | | | | |
| | N | 100 | 100 | 100 | 100 | 100 | | | | | |
| Bodily-Kinesthetic I. | r | 0,01 | ,604** | ,201* | 0,168 | ,369** | ,397** | | | | |
| | p | 0,925 | 0 | 0,045 | 0,096 | 0 | 0 | | | | |
| | N | 100 | 100 | 100 | 100 | 100 | 100 | | | | |
| Interpersonal Intelligence | r | -0,063 | ,542** | ,400** | 0,174 | ,278** | ,365** | ,343** | | | |
| | p | 0,535 | 0 | 0 | 0,084 | 0,005 | 0 | 0 | | | |
| | N | 100 | 100 | 100 | 100 | 100 | 100 | 100 | | | |
| Intrapersonal Intelligence | r | -,200* | ,679** | ,366** | -0,068 | ,254* | ,539** | ,427** | ,263** | | |
| | p | 0,046 | 0 | 0 | 0,503 | 0,011 | 0 | 0 | 0,008 | | |
| | N | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | | |
| Spiritual I. | r | -0,15 | ,698** | ,363** | 0,053 | ,354** | ,538** | ,344** | ,286** | ,616** | |
| | p | 0,137 | 0 | 0 | 0,601 | 0 | 0 | 0 | 0,004 | 0 | |
| | N | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | |
| Environmental Intelligence | r | -,219* | ,681** | ,301** | 0,034 | ,359** | ,564** | ,282** | ,242* | ,578** | ,579** | 1 |
| | p | 0,028 | 0 | 0,002 | 0,734 | 0 | 0 | 0,004 | 0,015 | 0 | 0 | |
| | N | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

**: Correlation is significant at the 0.01 level

* : Correlation is significant at the 0.05 level .BDNF: Brain Derived Neurotrophic Factor

Table 3 presents the results of the Pearson correlation analysis examining the relationships between participants' salivary BDNF levels and their Multiple Intelligence Profile Scale total score and its sub-dimensions. According to these results, no statistically significant correlation was found between BDNF and the Multiple Intelligence Profile Scale total score, nor with its sub-dimensions of linguistic, logical-mathematical, musical, bodily-kinesthetic, interpersonal, and spiritual intelligence ($p>.05$). These findings suggest that BDNF level does not have a strong relationship with the general multiple intelligence profile, but may have a weak and inverse association with specific domains such as spatial, intrapersonal, and environmental intelligence. When examining the relationship between the Multiple Intelligence Profile Scale total score and its sub-dimensions, as expected, positive and highly statistically significant correlations ($p=.000$) were identified. This indicates that the sub-dimensions contribute to the total score and reflect the general structure of multiple intelligence.

**Discussion**

In our study investigating the relationship between salivary BDNF levels and multiple intelligence profiles, no statistically significant association was found between salivary BDNF level and the total score on the multiple intelligence profile scale. In a study conducted by Flora et al. (2021), it was found that low serum BDNF levels were significantly associated with low general intelligence levels, and children with low BDNF levels had a 7.538 times higher risk of having below-average intelligence levels. At this point, the results of our study differ from those of Flora's study. It can be said that the primary factors contributing to these differing results include participant profile, the source of BDNF measurement, and the method of intelligence assessment.

When our study is compared with the research by Dinç et al. (2020), which examined serum BDNF levels in children with specific learning disabilities, significant parallels and differences emerge. Both studies reached a similar conclusion in not finding a simple and direct positive relationship between peripheral BDNF levels and general cognitive/learning profiles. However, while Dinç et al. detected no correlation between intelligence scores and BDNF, our current study, despite the lack of association between salivary BDNF levels and general multiple intelligence scores, demonstrated weak and negative correlations with specific intelligence domains such as spatial, intrapersonal, and environmental intelligence.

A meta-analysis conducted by Gobjila et al. (2022) revealed that a consistent correlation is not always found between circulating BDNF levels and cognitive impairments, and that BDNF alone may not be a reliable indicator of cognitive dysfunction. As Gobjila et al. also emphasized, the relationship between BDNF and cognitive functions is likely influenced by numerous confounding factors. In our sample, which consisted of healthy young adults, this complexity may have contributed to the absence of an observed direct link between BDNF levels and specific intelligence profiles.

In our study, it was determined that female students scored higher than male students in certain dimensions of intelligences, particularly musical, bodily-kinesthetic, intrapersonal, environmental and spatial intelligence. logical-mathematical and spatial intelligence. This finding presents an interesting contrast when compared with studies that examine individuals' self-estimates of their intelligence levels. For instance, Rammstedt and Rammsayer (2000) reported that males generally estimate their mathematical and spatial intelligence to be higher than females do, a phenomenon which they suggested could be influenced by gender stereotypes. Our findings, however, suggest that, at least in the context of measured abilities, these self-estimation tendencies may not always reflect actual performance.

In a study conducted by Reilly et al. (2022) examining self-estimates of intelligence, it was revealed that women tend to underestimate their own intelligence levels compared to men. This indicates the prevalence of gender differences in individuals' perceptions of their own abilities. However, in our study, when intelligence profiles measured by the multiple intelligence inventory were examined, female university students were found to have achieved higher scores than male students in some areas, including spatial intelligence. This finding points to a potential divergence between self-perceptions and actual performance, and suggests that women's competencies in specific intelligence domains may be more clearly demonstrated through measured tests.

**Conclusion**

This study has revealed that university students' salivary BDNF levels do not exhibit a strong linear relationship with their general multiple intelligence profiles. However, the identified weak and inverse connections between BDNF and specific intelligence domains such as spatial, intrapersonal, and environmental intelligence suggest that BDNF's role in different cognitive areas might be more specific and potentially complex, rather than providing general cognitive support. This implies that BDNF's interaction with cognitive functions may not always be as general and positively oriented as commonly assumed, but could differentiate according to the type of intelligence and the context. On the other hand, the significant differences observed in favor of

women in certain multiple intelligence areas once again underscore the importance of considering individual competencies and potential gender-related tendencies in educational approaches.

In light of these findings, several points should be noted. Given that a cross-sectional design was employed in this study, the causal direction of the relationship between BDNF and multiple intelligence could not be determined. Future longitudinal studies would aid in more clearly elucidating the potential causality between these variables. To enhance the generalizability of the research findings, it is important to replicate similar studies with larger and more diverse sample groups from different socio-cultural backgrounds. The underlying mechanisms of the weak negative correlations detected between BDNF and specific intelligence domains such as spatial, intrapersonal, and environmental intelligence (for instance, whether this is a compensatory response or a stress-related phenomenon) require more detailed investigation.

The relationship between the environmental intelligence sub-dimension and BDNF observed in this study is noteworthy. More comprehensive research into this type of intelligence and its interaction with BDNF could offer significant contributions to the field. Furthermore, this study utilized salivary BDNF levels and the Multiple Intelligence Profile Scale. Comparisons with studies employing different BDNF measurement sources and various intelligence assessment tools are important for evaluating the consistency of findings and the impact of different methodologies on results.

**Declaration**

**Ethical considerations**

The research was approved by the Bayburt University Research Ethics Committee (2025/ Decision no: 119). Before the data were collected by the researchers, participants were informed about the study in accordance with the Declaration of Helsinki and their written/verbal consent was obtained.All methods were conducted in accordance with relevant guidelines and regulations.

**Authors' Contribution**

S.O. and B.B. designed the study. S.O. and B.B. collected data. S.O. analyzed the data. S.O. and B.B. prepared the draft plan. All authors contributed to writing the manuscript. All authors read and approved the final manuscript.

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**Data Availability Statement**

The corresponding author upon reasonable request will provide data supporting the findings of this study.

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**Disclosure statement**

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**REFERENCES**

1. Bayraktar B. *Endocrine system* (*Endokrin sistem*). [In:] Taşkin E, Kocahan S, editors, *Physiology for Health Sciences* (*Sağlık bilimleri için fizyoloji*). Ankara: Akademisyen Kitabevi; 2020, 239–70.
2. Bayraktar, B. (2019). Investigation of the Physiology of Brain-Derived Neurotrophic Factor (BDNF) and Its Effects on Physiological Systems. Türkiye Vision: Multidisciplinary Studies 2019. Ekin Yayınevi.pp. 342-347.
3. Bekinschtein, P., Cammarota, M., Katche, C., Slipczuk, L., Rossato, J. I., Goldin, A., Izquierdo, I., & Medina, J. H. (2008). BDNF is essential to promote persistence of long-term memory storage. Proceedings of the National Academy of Sciences, 105(7), 2711-2716. https://doi.org/10.1073/pnas.0711863105
4. Binder, D. K., & Scharfman, H. E. (2004). Brain-derived neurotrophic factor. Growth Factors (Chur, Switzerland), 22(3), 123-131. https://doi.org/10.1080/08977190410001723308
5. Chao, M. V. (2003). Neurotrophins and their receptors: A convergence point for many signalling pathways. Nature Reviews. Neuroscience, 4(4), 299-309. https://doi.org/10.1038/nrn1078
6. Chen, J.-Q., & Gardner, H. (2005). Assessment based on Multiple Intelligences Theory. İçinde D. P. Flanagan & P. L. Harrison (Ed.), Contemporary intellectual assessment: Theories, tests, and issues (ss. 77-102). The Guilford Press.
7. Çelik, A., Erbaşı, A. & Erat Ocak L. (2024, 9-11 Mayıs). Adaptation Study of the Multiple Intelligences Profiling Questionnaire (MIPQ) into Turkish. 8th International The Economics Research and Financial Markets Congress with International Participation (IERFM), Mersin, Türkiye.
8. Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. Journal of Personality and Social Psychology, 92(6), 1087-1101. https://doi.org/10.1037/0022-3514.92.6.1087
9. Duman, R. S., & Monteggia, L. M. (2006). A neurotrophic model for stress-related mood

disorders. Biological Psychiatry, 59(12), 1116-1127. https://doi.org/10.1016/j.biopsych.2006.02.013

10. Erickson, K. I., Voss, M. W., Prakash, R. S., Basak, C., Szabo, A., Chaddock, L., Kim, J. S., Heo, S., Alves, H., White, S. M., Wojcicki, T. R., Mailey, E., Vieira, V. J., Martin, S. A., Pence, B. D., Woods, J. A., McAuley, E., & Kramer, A. F. (2011). Exercise training increases size of hippocampus and improves memory. Proceedings of the National Academy of Sciences of the United States of America, 108(7), 3017-3022. https://doi.org/10.1073/pnas.1015950108
11. Flora, R. et al. (2021). Braın-Derıved Neurotrophıc Factor (Bdnf) Serum and Intellıgence Levels of Elementary School Chıldren in Rural Areas, Seluma Regency, 12/1, 60-68.
12. Gardner, H. (1999). Intelligence Reframed: Multiple Intelligences for the 21st Century. Basic Books.
13. Gardner, H. (2011). Frames of Mind: The Theory of Multiple Intelligences. Basic Books.
14. Gliwińska, A., Czubilińska-Łada, J., Więckiewicz, G., Świętochowska, E., Badeński, A., Dworak, M., & Szczepańska, M. (2023). The role of brain-derived neurotrophic factor (BDNF) in diagnosis and treatment of epilepsy, depression, schizophrenia, anorexia nervosa and Alzheimer's disease as highly drug-resistant diseases: a narrative review. *Brain Sciences*, *13*(2), 163.
15. Gobjila, C., Ester, L., Said, M. A., Demurtas, J., Celotto, S., Smith, L., ... & Solmi, M. (2022). Brain Derived Neurotrophic Factor and Cognitive Dysfunction in the Schizophrenia-Bipolar Spectrum: A Systematic Review and Meta-Analysis. Frontiers in Psychiatry, 13, 827322.
16. Helms, J. E. (1992). Why is there no study of cultural equivalence in standardized cognitive ability testing? American Psychologist, 47(9), 1083-1101. https://doi.org/10.1037/0003-066X.47.9.1083
17. Huang, E. J., & Reichardt, L. F. (2001). Neurotrophins: Roles in neuronal development and function. Annual Review of Neuroscience, 24, 677-736. https://doi.org/10.1146/annurev.neuro.24.1.677
18. Kowiański, P., Lietzau, G., Czuba, E., Waśkow, M., Steliga, A., & Moryś, J. (2018). BDNF: A Key Factor with Multipotent Impact on Brain Signaling and Synaptic Plasticity. Cellular and Molecular Neurobiology, 38(3), 579-593. https://doi.org/10.1007/s10571-017-0510-4
19. Leal, G., Bramham, C. R., & Duarte, C. B. (2017). BDNF and Hippocampal Synaptic Plasticity. Vitamins and Hormones, 104, 153-195. https://doi.org/10.1016/bs.vh.2016.10.004
20. Lindsay, R. M., Wiegand, S. J., Altar, C. A., & DiStefano, P. S. (1994). Neurotrophic factors: From molecule to man. Trends in Neurosciences, 17(5), 182-190. https://doi.org/10.1016/0166-2236(94)90099-x
21. Lu, Y., Christian, K., & Lu, B. (2008). BDNF: A key regulator for protein synthesis-dependent LTP and long-term memory? Neurobiology of Learning and Memory, 89(3), 312-323. https://doi.org/10.1016/j.nlm.2007.08.018
22. Mandelman, S. D., Barbot, B., & Grigorenko, E. L. (2016). Predicting academic performance and trajectories from a measure of successful intelligence. *Learning and Individual Differences*, *51*, 387-393.
23. Murer, M. G., Yan, Q., & Raisman-Vozari, R. (2001). Brain-derived neurotrophic factor in the control human brain, and in Alzheimer's disease and Parkinson's disease. *Progress in neurobiology*, *63*(1), 71-124.
24. Neisser, U., Boodoo, G., Bouchard Jr., T. J., Boykin, A. W., Brody, N., Ceci, S. J., Halpern, D. F., Loehlin, J. C., Perloff, R., Sternberg, R. J., & Urbina, S. (1996). Intelligence: Knowns and unknowns. American Psychologist, 51(2), 77-101. https://doi.org/10.1037/0003-066X.51.2.77
25. Rammstedt, B., & Rammsayer, T. H. (2000). Sex differences in self-estimates of different aspects of intelligence. Personality and Individual Differences, 29(5), 869-880.
26. Reilly, D. Et al. (2022). Gender Differences in Self-Estimated Intelligence: Exploring the Male Hubris, Female Humility Problem, 13, 1-16.
27. Spearman, C. (1904). "General Intelligence," Objectively Determined and Measured. The American Journal of Psychology, 15(2), 201-292. https://doi.org/10.2307/1412107
28. Sternberg, R. J. (1985). Beyond IQ: A triarchic theory of human intelligence (ss. xvi, 411). Cambridge University Press.
29. Sternberg, R. J. (2019). A theory of adaptive intelligence and its relation to general intelligence. *Journal of Intelligence*, *7*(4), 23. Bathina, S., & Das, U. N. (2015). Brain-derived neurotrophic factor and its clinical implications. Archives of Medical Science, 6, 1164-1178. https://doi.org/10.5114/aoms.2015.56342
30. Şenses Dinç, G. et al. (2020). Serum Brain-Derived Neurotrophic Factor (BDNF) Level in Children with Specific Learning Disabilities, Turkish Journal of Psychiatry, 31/3, 185-191.
31. Thoenen, H. (1995). Neurotrophins and neuronal plasticity. Science (New York, N.Y.), 270(5236), 593-598. https://doi.org/10.1126/science.270.5236.593
32. Timmusk, T., Palm, K., Metsis, M., Reintam, T., Paalme, V., Saarma, M., & Persson, H. (1993). Multiple promoters direct tissue-specific expression of the rat BDNF gene. Neuron, 10(3),

475-489. https://doi.org/10.1016/0896-6273(93)90335-o

33. Visser, B. A., Ashton, M. C., & Vernon, P. A. (2006). Beyond g: Putting multiple intelligences theory to the test. Intelligence, 34(5), 487-502. https://doi.org/10.1016/j.intell.2006.02.004
34. Waterhouse, L. (2006). Multiple Intelligences, the Mozart Effect, and Emotional Intelligence: A Critical Review. Educational Psychologist, 41(4), 207-225. https://doi.org/10.1207/s15326985ep4104_1
35. Zuccato, C., & Cattaneo, E. (2009). Brain-derived neurotrophic factor in neurodegenerative diseases. *Nature Reviews Neurology*, *5*(6), 311-322.