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A Comparative Study about High School Teachers' Neuromyths in Turkey and Israel

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ABSTRACT

The aim of this study is to determine the neuromyths among Turkish and Israeli high school teachers and compare them across countries. The Educational Neuroscience Data Collection Scale, which was adapted into Turkish by Gülsün and Köseoğlu (2020) from Dekker et al. (2012) with regard to the brain and its functioning, was utilized as the data collection tool. Teachers working in Turkish high schools and teachers working in the Israeli Ministry of Education constituted the study sample. Between June 2019 and December 2020, there were 184 teachers (Turkey:112; Israel: 72) who volunteered to participate in the study. The research model is a relational investigation based on the general screening model. Data analysis included t-test and chi-square tests; when the independent variable was continuous, the t-test was used for independent groups, and when the independent variable was discrete, the chi-square approach was used, in accordance with the assumptions required to make group comparisons. According to the results of the study, there were significant differences between countries about the brain functions and the items related to neuromyths. However, no statistically significant difference was found between the country averages of the items in the data collection tool and the total item. With the intercountry comparison, it is considered that suggestions for eliminating neuromyths of teachers working in countries and suggestions to be made in teacher training programs will be important.

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1. Introduction

Humans have always had an interest in and a great deal of curiosity in the human brain. The popular media's increased interest with findings from brain research has been fueled by new discoveries in neuroscience. Brain research has begun to gain more value in the educational field, particularly since the 1980s. In this sense, Leslie A. Hart is known as the person who laid the foundations of the theory called brain-based learning or brain-adaptive teaching (Neve, Hart & Thomas, 1986). Geofrey and Renate Caine, on the other hand, developed and arranged Hart's brain-based learning principles and applied them to educational research. Eric Jensen guided the selection and use of suitable strategies based on the brain-based learning theory developed by Caines (Brodnax, 2004). Many researchers have been fascinated by how the brain learns in the learning and teaching

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process since the 1990s, and have linked this to education (Caine & Caine, 1995, 1997; Sylwesler, 1995; Diamond & Hopson, 1998; Jensen, 2000; Wolfe, 2001; Sousa, 2006). More recently, the phrases "brain-based learning" and "brain-based teaching" have been used to describe brain-training games and activities that have gained increased popularity. Comprising several subdisciplines of research, including but not limited to neuroscience, neurophysiology, developmental psychology, cognitive psychology, neurogenetics, and neurobiology, is the study of brain-based education, which takes place mostly in elementary and secondary school (Goswami, 2006; Sousa, 2006; Fischer, Daniel, Immordino-Yang, Stern, Battro, & Koizumi, 2007; Wilmes, Harrington, Kohler-Evans, & Sumpter, 2008; Caine et al., 2009; Williams, 2009; Sylvan & Christodoulou, 2010). Neuroscience findings have greatly enhanced the relevance and applicability of the educational practice for educators.

Unfortunately, misconceptions about neuroscience research have permeated educational practice. The myths about the brain that pervade media, advertising, and educational institutions are referred to as neuromyths. Neuromyths are spreading like wildfire across the medical community because they're wrong about the brain, according to Crockard (1996) (Howard-Jones, 2014). The OECD (an international organization dedicated to economic cooperation) set out to increase awareness of teachers' misunderstandings about the brain in 2002. The OECD (OECD) uses the term "neuromyth" to describe scientifically established facts that are misread, misinterpreted, or misrepresented to legitimize brain research in education and other fields (OECD, 2002). Neuromyths are currently contributing to the spread of practices that are not backed by brain research (Geake, 2008). This widely accepted neuromyth contends that we use only 10% of our brain, and that by stimulating the other 90%, we have the potential to drastically improve ourselves and our species. Increasing the amount of brain mass used in various training programs has led to the development of numerous training methods. Actually, each part of our brain works in isolation, not concurrently (Geake, 2008). Another neuromyth claims that sugar has an effect on a person's concentration and activity level. After consuming high-sugar foods and beverages, it is widely assumed that people, particularly youngsters, experience an increase in hyperactivity and a loss of attention. To be honest, there isn't a proven correlation between sugar consumption and children's cognitive abilities or behavior (Wolraich, Wilson, & White, 1995). These are some of the commonly known examples of neuromyths.

In the related literature, researchers have explored the prevalence of neuromyths in the educational system around the world in recent years. These studies' results reveal that different countries' beliefs follow a similar pattern. As examples of these studies, the belief to improve student achievements with information that matches students' preferred learning styles; it is very common among teachers in the United Kingdom and the Netherlands (Dekker, Lee, Howard-Jones, & Jolles, 2012), Argentina, Peru, Chile (Gleichgerrcht, Luttges, Salvarezza, & Campos, 2015), Turkey (Gülsün & Köseoğlu, 2020; Dündar & Gündüz, 2016; Karakus, Howard-Jones, & Jay, 2015), Greece (Deligiannidi & Howard-Jones, 2015; Papadatou-Pastou, Haliou, & Vlachos, 2017), Spain (Ferrero, Garaizar, & Vadillo, 2016), Portugal (Rato, Abreu, & Castro-Caldas, 2013), and China (Pei, Howard-Jones, Zhang, Liu & Jin, 2015). The belief in the 10% neuromyth has a global prevalence similar to that of the 10% neuromyth.

In the studies carried out, there are studies that determine the neuromyths of teachers in their own countries (Papadatou-Pastou, Haliou, & Vlachos, 2017; Düvel, Wolf, & Kopiez, 2017), and comparisons are made by identifying the neuromyths of teachers in different countries across different fields (Howard-Jones, 2014; Karakuş, 2013; Dekker et al., 2012). The results obtained from the mistakes (neuromytes) of biology teachers regarding their understanding of brain functions were discussed with the results of other similar researches that were conducted in the relevant literature as part of the research that was carried out by Gülsün and Koseoglu (2020) in the relevant national literature. This research was carried out within the scope of the study that was carried out in the relevant national literature. The findings of the study indicate that the themes that biology teachers cover in their classrooms that are connected to the structure of the brain and the neuromyths that they believe could potentially result in the dissemination of false information and the creation of new neuromyths. No previous research that is comparable to the one being investigated has been found in

the Israeli academic literature so far. As per the author's best knowledge there is no research in the related literature that compares the neuromyths of teachers in two countries. Thus, the aim of this study is to determine and compare the teachers' neuromyths in Turkey and Israel so that we can better understand their brain functioning and be evaluated internationally. With the intercountry comparison, it is considered that suggestions for eliminating neuromyths of teachers working in countries and suggestions to be made in teacher training programs will be important. The research problems addressed within the scope of the research are given below:

- What are the correct understandings of brain functions among Turkish and Israeli teachers?
- What are the common neuromyths (misunderstandings) among Turkish and Israeli teachers on brain functions?
- Is there a statistically significant difference in terms of correct information about teachers' understanding of brain functioning between teachers in Turkey and Israel?
- Is there a statistically significant difference between the teachers working in Turkey and Israel in terms of the mistakes (neuromyths) they know to be true regarding their understanding of brain functions?

2. Method

This study was approved by the ethics committee of Hacettepe University Academic Ethics Board Committee (approval number: E-35853172-600-00001501285). The research participants were told that their participation would be volunteer, and that no identifying information would be disclosed.

2.1. Research model

This study was designed as a correlational survey, which is one of the most widely used research types in the field of educational sciences, includes studies carried out to measure a phenomenon, orientation or to test a theory with real situations (Descombe, 2010). Utilizing the survey data, it is aimed to determine whether or if there is a change in two or more variables, as well as the degree of the change (Karasar, 2005). Furthermore, the relationship was investigated between survey items and certain variables from the survey data.

2.2. Participants

The participants of this study included the teachers working in Turkish high schools affiliated with the Ministry of National Education (MNE) and teachers working in the Israeli Ministry of Education. A total of 184 teachers, 112 of whom are Turkish teachers and 72 of whom are Israeli teachers voluntarily participated to the study between June 2019 and December 2020. Although one of the limitation of the study might be related to sampling and its external validity, the research, on the other hand, has high internal validity since the teachers who contributed to the study participated voluntarily. The data for the study was collected using the Google Questionnaire Form. The personal information of the sample of the study is given in Table 1.

2.3. Data collection tool

The Educational Neuroscience Data Collection Scale (ENDCS), which was adapted into Turkish by Gülsün and Köseolu (2020) was developed by Dekker et al. (2012) was used as the research's data collection tool. It is composed of 32 items 17 (1, 3, 6, 8, 13, 14, 16, 17, 18, 20, 23, 24, 26, 27, 29, 31) of which are for teachers' correct knowledge of brain functions and 15 of which (2, 4, 5, 7, 9, 10, 11, 12, 15, 19, 21, 22, 25, 28, 30, 32) are for detecting neuromyths. To determine the personal information of teachers, three questions (gender, professional experience, and frequency of reading science journals) were used as a demographic questionnaire.

Table 1. Descriptive statistics of the participants

		Turkey		Israel	
		n	**%**	**n**	**%**
Gender	Male	43	38.4%	10	13.9%
	Female	69	61.6%	62	86.1%
Professional experience	1-5 year	54	48.2%	6	8.3%
	6-10 year	30	26.8%	9	12.5%
	11-15 year	10	8.9%	15	20.8%
	16-20 year	12	10.7%	14	19.4%
	20 years and more	6	5.4%	28	38.9%
Status of reading science journals	No	18	16.1%	-	-
	Once a year	20	17.9%	15	20.8%
	Once in 3 months	21	18.8%	18	25.0%
	Once a month	28	25.0%	22	30.6%
	Once a week	25	22.3%	17	23.6 %
Total		112	100%	72	100%

The Cronbach Alpha coefficient is the most widely used method to test the reliability of the scale. If the Cronbach Alpha value is between 0.60 and 0.80, the questionnaire is reliable, and if it is between 0.80 and 1.00, the reliability of the questionnaire is quite high (Alpar, 2011). The findings regarding the reliability analysis of the scales are presented in Table 2.

Table 2. Scale reliability analysis results

Scale	**Cronbach's Alpha**	**Number of Items**
Data Collection Scale On Educational Neuroscience	.921	41

As seen in Table 5, the Cronbach's Alpha coefficient for the scale was calculated as 0.921. It can be claimed that the reliability of the scale is quite high.

2.4. Data analysis

To determine whether there is a significant difference between correct information about the meaning of brain functions and what participants believe is correct (neuromyths), consistent with the assumptions required to conduct a comparison between the groups, the t-test was used for independent groups when the independent variable was continuous, and the chi-square test was used for dependent groups when the independent variable was discrete. The chi-square test is used to determine if category data and survey results are different (Bas, 2001). In other words, the chi-square statistic is the most commonly employed non-parametric statistic (Ozdamar, 1999) for determining the independence of two categorical variables (Buyukozturk, Cokluk & Koklu, 2010). The study's threshold of significance was set at .05.

3. Results

According to first research problem Table 3 was constructed to understand the correct knowledge of brain functions.

Table 3 shows that the correct answer averages of Turkish teachers in items 6, 26, and 29, which are part of the correct information regarding their interpretation of brain functions in the data collection tool, were statistically significantly higher than those of Israel teachers. On the other hand, in items 13 and 20, the correct answer averages of teachers in Israel were shown to be statistically significantly higher than those in Turkey.

Table 3. Regarding the correct knowledge of teachers working in Turkey and Israel regarding their understanding of brain functions

Items of correct information regarding their understanding of brain functions in the data collection tool	Turkey			Israel			p
	Correct (f)	Incorrect (f)	I do not know (f)	Correct (f)	Incorrect (f)	I do not know (f)	
Item 1: We use our brains 24 h a day.	88	7	17	57	12	3	.924
Item 3: Boys have bigger brains than girls.	31	39	42	14	41	17	.207
Item 6: When a brain region is damaged, other parts of the brain can take up its function.	28	49	35	8	55	9	.020*
Item 8: The left and right hemispheres of the brain always work together.	32	48	32	18	36	18	.597
Item 13: Information is stored in the brain in a network of cells distributed throughout the brain.	56	14	42	50	14	8	.009*
Item 14: Learning is not due to the addition of new cells to the brain.	51	30	31	40	22	10	.18
Item 16: Learning occurs through modification of the brains' neural connections.	72	11	29	45	5	22	.807
Item 17: Academic achievement can be affected by skipping breakfast.	89	11	12	50	14	8	.124
Item 18: Normal development of the human brain involves the birth and death of brain cells.	79	7	26	49	13	10	.723
Item 20: Vigorous exercise can improve mental function.	92	12	8	71	0	1	.001*
Item 23: Circadian rhythms ("body-clock") shift during adolescence, causing pupils to be tired during the first lessons of the school day.	60	11	41	34	13	25	.403
Item 24: Regular drinking of caffeinated drinks reduces alertness.	49	31	32	28	38	6	.517
Item 26: Extended rehearsal of some mental processes can change the shape and structure of some parts of the brain.	68	16	28	22	24	26	.000*
Item 27: Individual learners show preferences for the mode in which they receive information.	101	3	8	58	4	10	.064
Item 29: Production of new connections in the brain can continue into old age.	79	8	25	35	17	20	.003*
Item 31: There are sensitive periods in childhood when it's easier to learn things.	107	0	5	67	0	5	.472

p<0.05; t-Test; chi-square test

The second research problem of the neuromyths of teachers working in Turkey and Israel are given in Table 4.

Table 4. Results related to neuromyths of teachers working in Turkey and Israel

Items related to neuromyths in the data collection tool	Turkey			Israel			p
	Correct (f)	Incorrect (f)	I do not know (f)	Correct (f)	Incorrect (f)	I do not know (f)	
Item 2: Children must acquire their native language before a second language is learned. If they do not do so neither language will be fully acquired.	38	59	15	49	17	6	.000*
Item 4: If pupils do not drink sufficient amounts of water (6-S glasses a day) their brains shrink.	21	47	44	18	32	22	.742
Item 5: It has been scientifically proven that fatty acid supplements (omega-3 and omega-6) have a positive effect on academic achievement.	62	5	45	61	2	9	.562
Item 7: We only use 10% of our brain.	29	47	36	22	30	20	.968
Item 9: Differences in hemispheric dominance (left brain, right brain) can help to explain individual differences amongst learners.	96	6	10	38	9	25	.085
Item 10: The brains of boys and girls develop vat the same rate.	34	47	31	32	25	15	.329
Item 11: Brain development has finished by the time children reach secondary school.	5	92	15	8	56	8	.469
Item 12: There are critical periods in childhood after which certain things can no longer be learned.	89	15	8	25	34	13	.000*
Item 15: Individuals learn better when they receive information in their preferred learning style (e.g., auditory, visual, kinesthetic).	109	0	3	71	1	0	.213
Item 19: Mental capacity is hereditary and cannot be changed by the environment or experience.	7	99	6	9	58	5	.144
Item 21: Environments that are rich in stimulus improve the brains of pre-school children.	104	2	6	70	1	1	.837
Item 22: Children are less attentive after consuming sugary drinks and/or snacks.	65	10	37	30	22	20	.030*
Item 25: Exercises that rehearse co-ordination of motor-perception skills can improve literacy skills.	82	10	20	64	3	5	.517
Item 28: Learning problems associated with developmental differences in brain function cannot be remediated by education.	27	59	26	10	51	11	.014*
Item 30: Short bouts of co-ordination exercises can improve integration of left and right hemispheric brain function.	93	0	19	61	1	10	.213
Item 32: When we sleep, the brain shuts down.	4	92	16	4	64	4	.216

p<0,05; t-Test; chi-square test

According to Table 4, the neuromyth averages of teachers working in Turkey were statistically significantly higher than those working in Israel in items 2 and 22 of the data collection tool related to neuromyths (chi-square test). The neuromyth averages of teachers working in Israel were found to be statistically significantly higher than those working in Turkey in items 12 and 28.

The third research issue is that there is no statistically significant difference between teachers in Turkey and Israel in terms of accurate knowledge of brain function ($p>0.05$).

The forth of the relationship between the country averages of the items in the data collection tool of the study and the total item. There is no statistically significant difference was found between the averages of the items in the data collection tool by country and the total item ($p>0.05$).

4. Discussion

Neuroscience, biology, and psychology have all discovered important new information about the relationships between learning and the brain, with regards to learning opportunities, patterns, emotions, meaningfulness, environments, body rhythms, attitudes, stress, traumas, assessments, music, movement, gender, and enrichment. A new approach called "brain-based learning," which incorporates new brain research with conventional education methods, states that schools may be reconfigured to provide complete learning experiences (Jensen, 2008). Since, it is stated in the researches that when a learning environment suitable for learning is provided to students, when graduation rates increase, learning difficulties and discipline problems decrease, and the love of learning in individuals will develop as an outcome of this (Geake and Cooper 2003; Geake, 2005; Pickering & Howard-Jones, 2007; Howard-Jones, 2010). As a result of these studies, it is possible to conclude that organically arranging the brain within the framework of the best learning style is the simplest and most important educational reform ever initiated. Teachers' professional field knowledge, as educational actors, plays a critical influence in students' learning and success in this regard (Mizell, 2010). However, research suggests that keeping up with the fast-moving nature of neuroscience and general research on the brain is one of the challenges faced by today's educators (Jensen, 2008).

The prevalence of neuromyths in education is a problem because it can result in a waste of limited educational resources. Due to the prevalence of neuromyths, teachers develop learning methods that are inefficient in reaching intended goals and are not appropriate for the basic aims of education, as well as time and resource losses (Howard-Jones, 2014). Considering that neuromyths are the biggest obstacle to the development of an effective learning pattern (Wilmes et al., 2008; Karakuş, 2013) between neuroscience and education, within the scope of the research, the correct known mistakes (neuromyths) of teachers working in Turkey and Israel were determined in order to make sense of their brain functions and a comparative evaluation was made between countries.

According to the results, three (Item 20: "Vigorous exercise can improve mental function"; Item 27: "Individual learners show preferences for the mode in which they receive information"; Item 31: "There are sensitive periods in childhood when it's easier to learn things") in Turkey and two (Item 20: "Vigorous exercise can improve mental function" and Item 31: "There are sensitive periods in childhood when it's easier to learn things") in Israel were correct out of a total of 17 items in the data collection tool including correct information regarding brain functions. Furthermore, two in Turkey (Item 15: "Individuals learn better when they receive information in their preferred learning style (e.g., auditory, visual, kinesthetic" and Item 21: "Environments that are rich in stimulus improve the brains of pre-school children") and two in Israel (Item 5: "It has been scientifically proven that fatty acid supplements (omega-3 and omega-6) have a positive effect on academic achievement" and Item 15: "Individuals learn better when they receive information in their preferred learning style (e.g., auditory, visual, kinesthetic") were found to be correct out of a total of 15 items in the data collection tool consisting of neuromyths connected to the brain functions. According to the results, while teachers in Turkey and Israel are generally interested in the subject, they have insufficient knowledge

of it. Among the studies conducted in the relevant literature, Dekker, Lee, Howard-Jones, and Jolles (2012) found that teachers working in primary and secondary schools in different countries (England and the Netherlands) and teachers working in primary and secondary schools in Turkey (see, Karakuş, 2013) had shown similarities regarding the functioning of the brain. The findings of this study displayed similar results with Howard-Jones (2014), where teachers' neuromyths in England, the Netherlands, Turkey, Greece, and China were determined and compared.

According to the results in this study, there was no statistically significant difference between average scores obtained from the scale between Turkey and Israel. It shows, however, that teachers' neuromyths about the structure of the brain in Turkey and Israel might enhance false information in the teaching process and contribute to the formation of new neuromyths. Studies in the related literature based on this perspective are being conducted with the aim of removing neuromyths from educational practices and policies (Ferreira & Rodríguez, 2022; Dekker & Kim, 2022; Grospietsch & Lins, 2021; Pávová & Valent, 2020; Goswami, 2010; Howard- Jones et al., 2007; Howard-Jones, 2010). The countries covered in these studies are Turkey (Karakus et al., 2015), Greece (Deligiannidi & Howard-Jones, 2015; Papadatou-Pastou et al, 2017), Argentina (Hermida, Segretin, Soni Garcia, & Lipina, 2016), East China (Pei et al., 2015), Spain (Ferrero et al., 2016) and Latin America (Gleichgerrcht et al., 2015). They examined the brain perception patterns of teachers in the countries and regions where these studies were conducted, both in general and specifically. It is considered that the results of this research are important both in terms of not spreading neuromyths in education systems and preventing the use of teaching practices that are not based on a certain basis and evidence in education systems around the world.

5. Conclusion

Brain-related research is essential to every field that relates to the individual, and it is essential that every sector benefit from the findings of inter-disciplinary research. In accordance with the goal of the study, the errors (neuromytes) of high school instructors in Turkey and Israel on their understanding of brain processes were transmitted by analyzing similar research findings in the relevant literature. The results of this study indicate that the neuromyths held by high school teachers in Turkey and Israel regarding the structure of the brain can enhance the prevalence of erroneous information in the classroom and lead to the emergence of new neuromyths. According to the results, cross-country comparisons of the neuroscience-education relationship within education systems cannot be generalized. One reason for this is that there are cultural variances in how people view the brain in different countries. Since Turkish teachers feel that there are critical periods in the learning process and that a mother tongue must be acquired before studying a second language, they believe more strongly than Israeli teachers that there are critical periods in the learning process. Second, the teachers who are taking part in the study are from high schools, and the number of participants is low. Thus, the results cannot be generalized to other settings.

According to the results of the research, offers for future studies and applications in the field are presented below:

- It is considered important to organize in-service trainings and workshops for educators in collaboration with Ministries of Education and universities and to plan these trainings taking into account their feedback and disseminating effect, in order to eliminate neuromyths related to brain functions that form the basis of neuroscience research.
- It is advised in terms of the generalizability of the results of the researches to be carried out by applying different sampling methods in different branches.
- Studies, where mixed method research methods are applied, are thought to be important in terms of reaching more detailed information in the removal of neuromyths.
- Researchers can use the cyclical structure of the action research design (supervision, analysis, planning, and implementation), a qualitative research method, to eliminate neuromyths. If the

researcher believes it is insufficient, it is expected that additional significant results will be achieved since a new action research design cycle will be made.

- With focus group studies where qualitative research methods will be used in the elimination of neuromyths, observations can be considered as data sources as well as the opinions of stakeholders and the opinions of individuals about neuromyths.

As a result, the relationship between neuroscience and education has limited potential for clarifying educational issues. As a consequence, it is assumed that in order to optimize the brain in the learning process, efforts should be made to make learning opportunities more emotional, meaningful, and relevant by molding them in realistic doses rather than reshaping them around neuroscience results.

Compliance with Ethical Standards

Conflict of Interest: The author declare that they have no conflict of interest.

Ethical Approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee.

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