Original article

Pedagogical Experience in the subject Food Chemical Analysis I from an approach to Neurodidactics

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ABSTRACTS

The objective of the research was to assess the pedagogical experience in the subject Food Chemical Analysis I from an approach to neurodidactics. A retrospective longitudinal investigation was carried out in the period from September 2016 to February 2019. Document analysis and observation guides were used within the empirical methods. It is concluded that the pedagogical experience was satisfactory, which is evidenced by the results obtained and the significance of the application of the foundations provided by neuroscience and neurodidactics is highlighted.

Keywords: Food Chemical Analysis I; Neurosciences; Neurodidactic; Teaching-learning strategies.

Received: 05/04/2021

Accepted: 25/08/2021

Introduction

The learning process has been studied throughout history by pedagogy and other disciplines, such as philosophy, psychology and other related disciplines, and it is the central element that mobilizes educational processes. At present, scientific progress and

technology have allowed studies on learning to be abundant, especially in relation to the substrate of this complex process: the brain (Araya and Espinoza, 2020).

In order for the teaching-learning process to be effective, it is necessary to be intentional about the students' learning, in which the cognitive components must be considered, as well as the emotional ones; for example: the interest in what is being learned. In such a scenario, cognitive neuroscience and neuroeducation are established according to current literature as potential areas to optimize the design and educational strategies by providing guidelines for the improvement of this process, based on the theoretical and empirical study of the mental operations of the brain, such as thinking, memory, attention and complex forms of perception (Araya and Espinoza, 2020).

In the last 20 years, neuroscience has experienced a great development. Although it is a relatively recent discipline, it brings relevant and significant changes that have originated a true revolution in the teaching and learning process at the theoretical level. Neurosciences have brought to the field of education an understanding that goes beyond academic knowledge and cognitive processes to encompass the understanding of the role of emotions and their regulation, the role of social aspects, and of reward systems, which are articulated with the ability to be motivated, self-motivated and regulate effort and one's own behavior (Peña, 2019).

One of the disciplines that is being impregnated by Neuroscience, is Didactics, giving rise to Neurodidactics that integrates contributions from didactics, neuroscience, psychology and pedagogy and whose objective is to improve the teaching system of teachers in different subjects, knowing the cognitive processes of students (Peña, 2019).

Neurodidactics involves a new field of research that seeks to find the most effective way to teach by using the most significant neuroscientific contributions applied to education (Benavidez and Flores, 2019). Thus, Neurodidactics is constituted in the evaluation, improvement and transfer of neuroscientific knowledge applied to the teaching-learning process, so it should help teachers to design classes more efficiently. Neurodidactics is a branch of pedagogy based on neuroscience, which gives a new orientation to education. It is the union of cognitive sciences and neurosciences with education, which aims to design more efficient didactic and methodological strategies, which not only ensure a theoretical and philosophical framework, but also promote greater brain development, (greater learning) in terms that educators can interpret (Justis, 2019).

In this sense, one of the academic disciplines that students of the degree in Food Science receive in their curriculum is Food Evaluation and Control; this discipline

includes the conceptual, theoretical and methodological basis that allows the professional to determine the fitness for consumption of both natural and processed foods. Its object of study is to evaluate the fulfillment of the indicators of the quality of foods and their correspondence with the expressed or implicit needs of man.

The subject Food Chemical Analysis I is part of this discipline, it is a theoretical-practical subject, of basic professional training, located in the third semester (2nd year) of the E curriculum in this career. Three topics are taught in this course: Introduction to Chemical Analysis of Food, Volumetric Analysis and Gravimetric Analysis. On the one hand, in the first subject one of the objectives is to perform calculations aimed at expressing the concentration of solutions and of a component in a food, on the other hand, in the second subject there are objectives oriented to the preparation of solutions of approximate and exact concentration and to the determination of the concentration of a chemical component in a food.

However, the academic results obtained in practical classes and laboratory practices on the preparation of solutions show that students in the second year of the Bachelor's Degree in Food Science have difficulties in this subject. The experience of the authors allows them to suggest that the causes are given by the insufficiencies that students maintain in the resolution of chemical calculations, since they reveal limitations in skills related to problem solving, as well as practical skills and strategies to appropriate the contents of the subject.

This allowed to identify as a scientific problem: How to contribute to improve the preparation of the students of the second year of the degree in Food Science in the resolution of chemical calculations?

On the contrary, the inadequate application of teaching strategies, the lack of neuropedagogical preparation of teachers, and the omission of resources to manage intrinsic motivation towards learning, which generates conformism and disinterest in them, can influence the students' inadequacies, which detracts from the significance of learning.

Consequently, it is novel to deepen from the pedagogical research on the optimization of learning processes with the support of the fundamentals offered by neurosciences, particularly neurodidactics focused on the neuro-biopsychosocial improvement of students, and the assessment of its impact on their integral development.

Based on the above assumptions, the objective of the research is to evaluate the pedagogical experience for the treatment of the topic on the preparation of solutions in

the subject Chemical Analysis of Food I from a neurodidactic approach, at the University of Camagüey Ignacio Agramonte Loynaz.

Development

This experience has been applied during the last four academic years. For the assessment of the results obtained, a retrospective longitudinal research is presented for the period from September 2016 to February 2019. Theoretical methods such as analysis and synthesis and inductive-deductive were used for the theoretical references of the subject and its current state in the treatment of the literature consulted.

Among the empirical methods used were:

The analysis of documents which allowed the study of the discipline Evaluation and Control of Food in the curriculum E of the degree in Food Science, as well as the program of the subject Chemical Analysis Food I.

The elaboration of observation guides for the evaluation of the abilities to identify the method of preparation of dissolutions, to make calculations and to execute the method in the different forms of organization of the teaching dedicated to this subject.

The research was based on the design of a teaching-learning strategy for the treatment of the topic on the preparation of solutions, since the teaching and learning process is the effective and academic communication that takes place between the students and the teacher with the purpose of building significant learning, through strategies and methodologies. This is the way in which the student is molded not only academically, but also humanly, facilitating their emotional development.

On the other hand, it is proposed that learning involves the active processing, storage and retrieval of the information received by the student. While the intentional teaching by teachers should help those who wish to learn so that they can adequately develop their skills to process information and apply them systematically to the solution (Camacho, Alemán & Onofre, 2019).

Hence, when making the distinction between teaching strategies and learning strategies, it is necessary to start from the idea that the teaching-learning process is synthesis, so it has been a mistake to divorce one from the other. In fact, the authors of the research are of the opinion that defining teaching strategies and learning strategies does not imply

divorce, but rather an analytical understanding of the role of each actor (teachers and students) in the complex process, which is undoubtedly not the same.

Thus, both types of strategies are distinguished if we consider that, in the case of teaching strategies, the emphasis is on the planning, design, sequencing, elaboration and realization of the content; while learning strategies refer to the students' actions that occur during learning and influence motivation, assimilation, interpretation, retention and transfer of information.

One of the teaching strategies used was illustrations understood as visual representations of concepts, objects or situations of a specific theory or topic (photographs, drawings, diagrams, graphs, dramatizations, etc.) and can be classified as: descriptive, constructional expressive, functional, logical-mathematical, algorithmic and data arrangement (Varela, García, Menéndez, & García, 2017).

With this type of strategy the expected effect on the learner is that it facilitates the visual coding of information, the example described is of the algorithmic type, this strategy was used in the subject for the self-preparation of students in view of a practical class and three laboratory practices.

Likewise, within neuroscience it is mentioned that for students to learn well it is necessary to use graphics, diagrams, information and communication technologies, as well as didactic materials. That is why the strategy followed has taken into account this fundamental idea, so that the theoretical explanation is done using graphics, colors and music to not only capture the student's attention, but in turn develop their skills and constitute for them a strategy for learning.

1. **Procedures carried out for the treatment of the topic on the preparation of solutions in the subject Aliment Chemical Analysis I.**
2. Description by school year.

In the 2016-17 academic year:

In the lecture on Introduction to volumetric analysis, the professor explains and describes the different methods of preparation of solutions, with examples and their respective calculations. At the end of the lecture, the description of the different methods of preparation of solutions is written on the blackboard in the form of an algorithmic diagram, and then the teacher guides the students through the exercises for the practical class and gives them the diagram which they can use as a basis for orientation.

In the 2017-18 academic years:

The procedure was the same as in the previous course, with the difference of using the diagram, in the form of a power point, once the lecture is finished the professor guides them through the exercises of preparation of solutions for the practical class and also guides them that the diagram can be downloaded from the File Transfer Protocol (ftp) of the faculty. In this way, the diagram is used at the time of the lecture; the student should use it in their preparation prior to the practical class and later in the laboratory practices.

In the 2018-2019 academic year:

The procedure is repeated the same as in previous courses. The difference of the diagram (figure 1.) is based on the fact that the power point presents visuals changes in the colors. The most prevalent colors in the elaboration of the diagram are blue, which transmit serenity and confidence, in contrast to red which comunicates vitality and activity, as well as words in yellow wich helps concentration. These colors generate a greater retention of information; it has been proven that using colors for exercices or topics under study gives a wide margin of significant learning in students (Romero y Chilian, 2017).

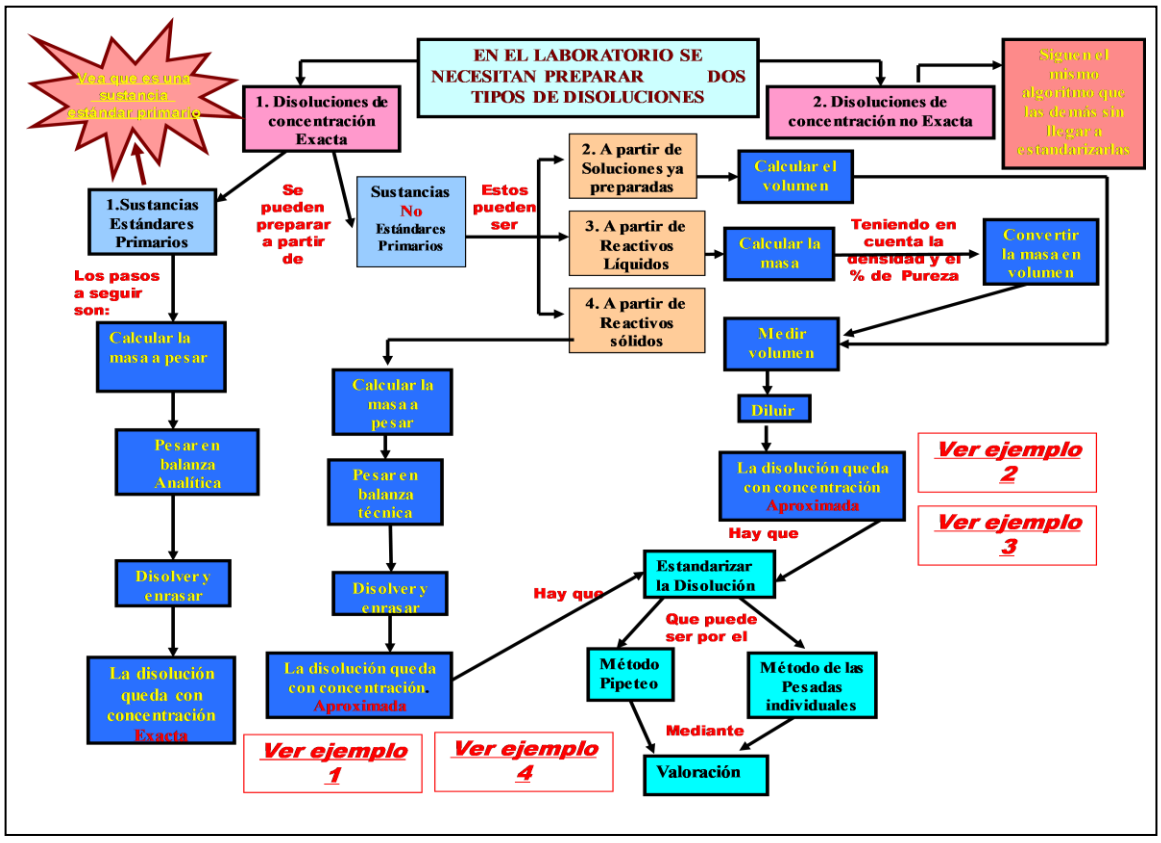


Figure.1. Algorithmic Diagram

Source: Self elaboration

In the design of the slide of the algorithmic diagram, the presentation is made as clear and brief as possible, it does not appear as shown in the previous figure, because the slide should not be overloaded with too much information, but it should appear as the student selects the method, another characteristic of the diagram is that it is not a static slide, but it is animated, it contains hyperlinks that allow the student to consolidate and internalize the information by actively processing it, through repetition as many times as necessary.

Constant and repeated practice is an effective way to learn something because it strengthens the networks, making the activated neuronal pathways more efficient to execute that learning and a last characteristic of the power point is that it has pleasant music inserted.

Evaluation of the skills developed by the students.

Guidelines were developed for the evaluation of the following skills:

Table 1: Guidelines for assessing the skills developed in students

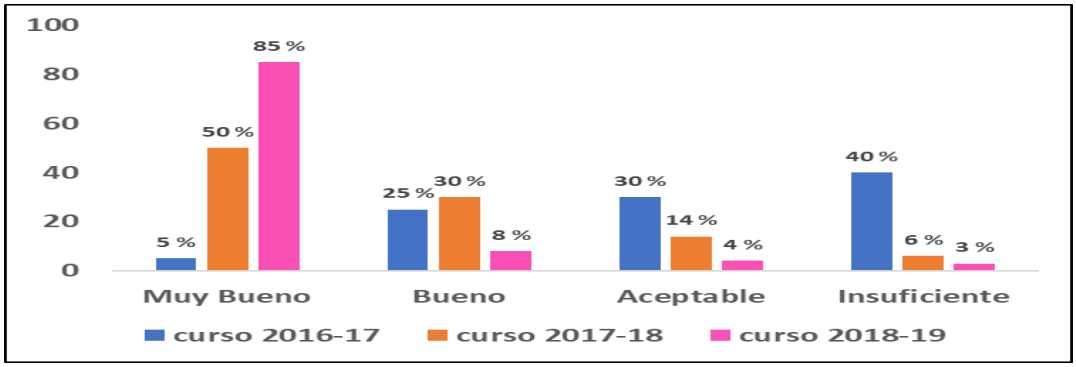
Sistema de habilidades	Muy Bueno	Bueno	Aceptable	Insuficiente
Identificar el método de preparación de disolución.	Identifican el método y sigue de manera muy satisfactoria el algoritmo para desarrollar el mismo.	Identifican el método y sigue de manera satisfactoria el algoritmo para desarrollar el mismo.	Identifican el método y no sigue el algoritmo para desarrollar el mismo.	No identifican el método y no sigue ningún algoritmo para desarrollar el mismo.
Realizar los cálculos.	Realizan los cálculos siguiendo todas las operaciones del algoritmo.	Realizan los cálculos siguiendo la mitad de las operaciones del algoritmo.	Realizan los cálculos siguiendo menos de la mitad de las operaciones del algoritmo.	No logran realizar los cálculos.
Ejecutar el método.	Ejecutan el método escogido correctamente. Realizan todas las operaciones necesarias y suficientes.	Ejecutan el método escogido correctamente. Realizan más de la mitad de las operaciones necesarias y suficientes.	Ejecutan el método escogido correctamente. Realizan menos de la mitad de las operaciones necesarias y suficientes.	Ejecutan el método escogido incorrectamente. Realizan menos de la mitad de las operaciones necesarias y suficientes

Fuente: Elaboración propia

Results obtained.

For the evaluation of the different skills, the results obtained by the students in the practical class and in the three laboratory practices were taken; the processing was carried out through the interpretation and graphic representation of the data with Excel software.

Ability to identify

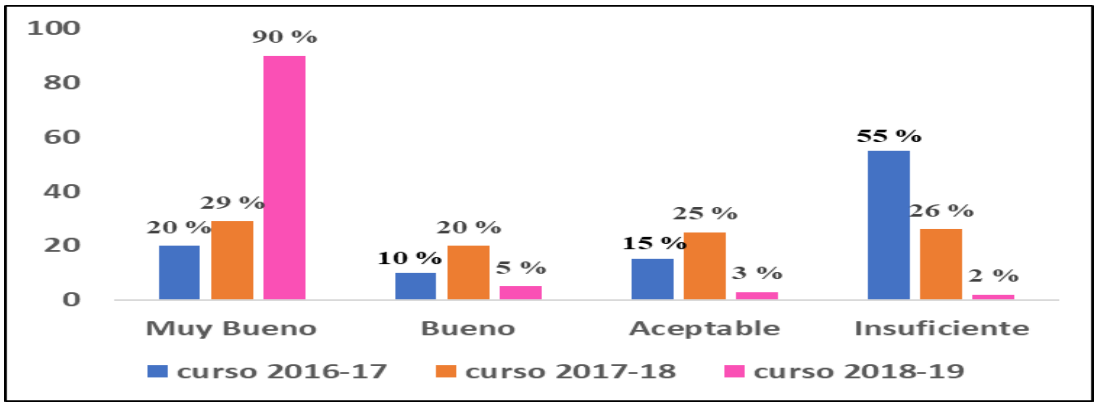


Graph. Evaluation of the ability to identify the method of preparation of solutions.

Source: Self elaboration

Regarding the ability to identify the method of preparation of dissolutions which was evaluated in the practical class, it is observed in the graph. 1 that there was an increase of 85 % of students evaluated as very good in the course 2018-19. The results are endorsed because the students from the algorithmic diagram and according to the data offered in the exercises can identify whether the path to follow is that of a primary standard or not.

Ability to perform calculations.

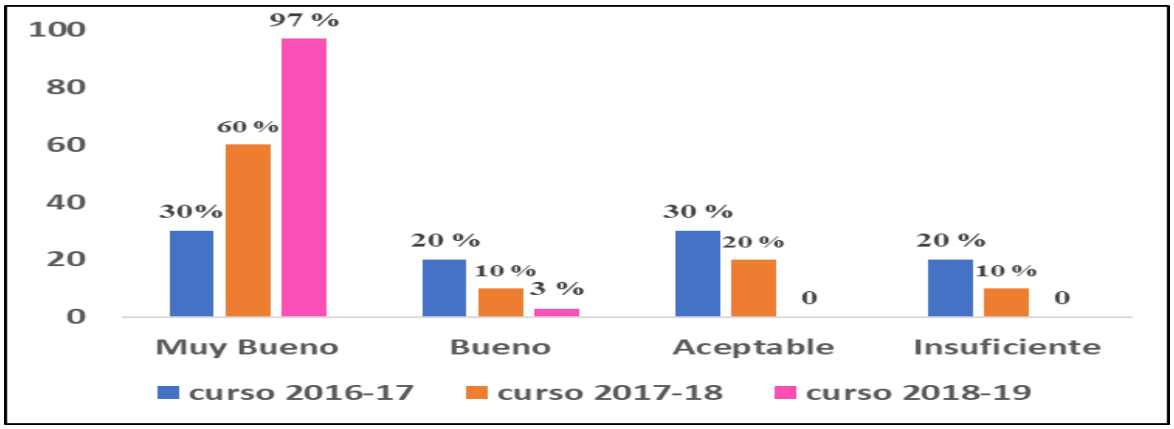


Graph. Evaluation of the ability to perform calculations

Source: Self elaboration

The ability to perform calculations, as well as the previous one, was evaluated in the practical class. It is observed in graph 2 that there was an increase of 90% of students

evaluated as very good in the 2018-19 course. These satisfactory results corroborate that the student when applying the algorithmic diagram can perform the calculations, since he/she identifies the path to follow according to the data offered in the exercises (molar mass, volume, density and purity). Ability to execute the method.



Graph. Evaluation of the ability to execute the dissolution preparation method.

Source: Self elaboration

This skill was evaluated in the laboratory practices. It is observed in graph 3 that there was an increase of 97 % of students evaluated as very good in the 2018-19 course. These satisfactory results ratify that the student upon appropriating the algorithmic diagram can execute the experimentally identified method and perform all the necessary and sufficient operations.

Significance of the results obtained from neurodidactics.

The satisfactory results obtained with the teaching-learning strategy in the last course are due to the application by the authors of the theoretical foundations provided by different researchers dedicated to neuroscience and neurodidactics. These sciences provide procedures that are taken into account in the action within the teaching-learning process and can therefore be used to support teaching praxis. In addition, neurodidactics makes the most of the students' knowledge, abilities and skills, of their brain functioning for the acquisition of new information.

We agree with Maureira (2010) when he points out that neuroscience is the discipline in charge of studying the brain and how it gives rise to behavior and learning. The knowledge provided by this discipline is a valuable tool in the educational field, since it teaches about the plasticity of the nervous system, the importance of the classroom environment, the bases of motivation, attention, emotions and memory, as essential constituents of the teaching-learning process.

For an educator, the most important thing is to understand Neuroscience as a way to know the brain in a broader way - how it is, how it learns, how it processes, registers, conserves and evokes information, among other things - so that from this knowledge it can improve the learning proposals and experiences that take place in the classroom.

Similarly, neuroscience uses the results obtained from various techniques for the study of the brain, including molecular and cellular biology, genetics, neuroanatomy, and neuroimaging, the latter of which have revolutionized the field of understanding the nervous system. The possibility of seeing the brain in action every time a function or behavior is performed, allows us to understand how different areas of the brain give rise to such complex dynamics as memory and learning (Maureira, 2010). Precisely, neurons are responsible for learning, since the brain can learn because the connections between brain cells are permanent. Learning is based on the connectivity of different areas of the brain; it is learned by making new connections between brain cells and then reinforcing them through repetition (Araya and Espinoza, 2020). In this sense, the presence of the neurotransmitters acetylcholine and dopamine increase learning levels in students, which is why they can systematize information in an already existing connection.

Therefore, it is a matter of taking advantage of the fundamentals of these sciences to know how the brain works, this being the starting point within the teaching-learning process. The teacher must teach to learn both in a group and individual way, learning with pleasure, since the brain itself produces what it has truly learned in a meaningful way.

Colors.

Regarding colors according to researchers Clemente, Cedeño, Valledor, Valdés and Ávila, (2015), describe that in Didactics there is no reference to the use of color as an element involved in the speed of perceptual processes related to visual word recognition. Therefore, it is possible to optimize the visual recognition of words in non-linear text used in visual presentations within the teaching-learning processes, reducing time and energy expenditure during recognition through the efficient use of color, because it not only fulfills an aesthetic function, but also allows increasing speed in this process.

Thus, the colors strongly absorbed by the retina are blue, orange and yellow, in fact, very striking colors, very important to create high contrasts between the component elements of the words or differentiate them from the background which increases the

speed in their recognition. These colors are the ones that predominate in the algorithmic diagram.

Music.

Regarding music, it is an element considered relevant in neurodidactics, because it is evidenced that due to its multisensory characteristics it stimulates the amygdala and the hippocampus, thus facilitating learning. It is an element that stimulates the dialogue between the two hemispheres of the brain since it allows a dynamic balance between the capacities of both. It is one of the elements with the greatest capacity for neurofunctional and neuropsychological integration (Pino, 2011).

Neuroscience confirms that the brain processing of music simultaneously combines communication, cognition, emotion and movement, and triggers biological processes of evident transformation that affect mood, stimulation of memories, group integration, physical, mental and emotional well-being (Pino, 2011).

Music produces a state of relaxation associated with the release of serotonin, pleasure, which naturally in the human organism is accompanied by dopamine and endorphins. It is evident that this emotional character is what gives strength to the messages channeled by music, and its facility to be engraved in the memory. These particularities of power point make the information provided with this strategy contribute to the appropriation of knowledge by students.

The authors consider that the satisfactory results obtained in the last course are possible because the novel, attractive and surprising stimuli activate the release of dopamine, a neurotransmitter involved in motivation and enthusiasm. Dopamine increases the focus of attention, enhancing the consolidation of new information, its connection with related memories and its passage to long-term memory.

That is to say, one learns better when a certain content or subject presents certain emotional content, a pleasant educational climate is also important, hence, motivation and emotion direct the attention system, which decides what information is stored in the neuronal circuits and, therefore, learning is achieved.

Conclusions

The evaluation of the pedagogical experience for the treatment of the topic on the preparation of solutions in the subject Chemical Analysis of Food I from a neurodidactic approach is satisfactory, as evidenced by the results obtained from the instruments applied.

The significance of the results obtained from neurodidactics stands out, since in order to promote learning it is necessary to excite the brain, a foundation that is found from the beginnings of pedagogy, since everything that produces complacency, pleasure or contentment in the learning instances is reinforced in the memory. In addition, the sequence of providing information and reinforcing it through the different forms of organization of teaching contributes to the neurons being activated and making contact with each other, creating synapses. This is part of neuronal plasticity, which is what happens when one learns; the cerebral cortex creates new synapses that establish new networks of neurons.