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Nutrition, cognition and emotion: neuropsychological foundations and tools for nutritionists

Nutrición, cognición y emoción: fundamentos neuropsicológicos y herramientas para nutricionistas

Nutrição, cognição e emoção: bases e instrumentos neuropsicológicos para nutricionistas

ABSTRACT

There are several studies on the relationship between nutrition and cognition or nutrition and emotion. But the science of nutrition transcends nourishment and eating. It involves interrelated factors that need to be verified and used to better understand the individual and the populations served by the nutritionist and the proposition of ways to solve and/or improve these demands. To this end, there are tools that enhance dietary and nutritional assessment and provide a better understanding of dietary habit formation. This theoretical essay on neuropsychological instruments used for assessment of adults and elderly contributes to nutritional assessment, specifying cognitive functions and their relationships with nutritional and emotional factors of the individual. A survey of neuropsychological assessment instruments or those with cognitive and emotional constructs was performed. Cognitive evaluation and the relationship of emotion with food were verified. It is thought that this is a basic guide for the nutritionist to increase his assessment beyond the traditional.

DESCRIPTORS: Nutrition; Cognition; Emotion; Neuropsychological Tests.

RESUMEN

Existen varios estudios sobre la relación entre nutrición y cognición o nutrición y emoción. Sin embargo, la ciencia de la nutrición trasciende la nutrición y la alimentación. Se trata de factores interconectados que deben ser verificados y utilizados para comprender mejor al individuo y las poblaciones atendidas por el nutricionista y la propuesta de formas de resolver y / o mejorar estas demandas. Para ello, existen instrumentos que aumentan la valoración alimentaria y nutricional y permiten un mejor conocimiento de la formación de hábitos alimentarios. Este ensayo teórico sobre los instrumentos neuropsicológicos utilizados para evaluar a adultos y ancianos contribuye a la evaluación nutricional, especificando las funciones cognitivas y su relación con los factores nutricionales y emocionales del individuo. Se realizó una encuesta de instrumentos de evaluación neuropsicológica o que tengan constructos cognitivos y emocionales. Se verificó la evaluación cognitiva y la relación entre emoción y comida. Se cree que esta es una guía básica para que los nutricionistas aumenten su evaluación más allá de la tradicional.

DESCRIPTORES: Nutrición; Cognición; Emoción; Pruebas neuropsicológicas.

RESUMO

Há diversos de estudos sobre a relação entre nutrição e cognição ou nutrição e emoção. Porém a ciência da nutrição transcende o nutrir e o comer. Envolve fatores interligados que precisam ser verificados e utilizados para melhor compreensão do indivíduo e das populações atendidas pelo nutricionista e da proposição de modos de resolução e/ou melhora destas demandas. Para tanto, existem instrumentos que incrementam a avaliação alimentar e nutricional e proporcionam melhor compreensão da formação do hábito alimentar. Este ensaio teórico sobre instrumentos neuropsicológicos utilizados para avaliação de adultos e idosos contribui para a avaliação nutricional, especificando as funções cognitivas e suas relações com os fatores nutricionais e emocionais do indivíduo. Realizou-se levantamento dos instrumentos de avaliação neuropsicológica ou que possuam construtos cognitivos e emocionais. Verificou-se a avaliação cognitiva e a relação da emoção com a comida. Pensa-se que este seja um guia básico para o nutricionista incrementar sua avaliação para além da tradicional.

DESCRITORES: Nutrição; Cognição; Emoção; Testes Neuropsicológicos.

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Helena Beatriz Rower

Master in Public Health (University of Vale do Rio dos Sinos, Unisinos), Nutritionist

ORCID:0000-0002-2192-8778

Denise Ren da Fontoura

PhD in Language Sciences (Universidade Nova de Lisboa, UNL), Speech Therapist.

ORCID: 0000-0002-1146-1932

INTRODUCTION

Neuropsychology can be understood as an interdisciplinary science that includes professionals from different backgrounds. There is still no consensus on the direction of the association between food and mental health, since adequate food can positively influence the individual's lifestyle and mental states. On the other hand, there are those who find that mental health and lifestyle influence eating habits as well as those who claim to be a bidirectional relationship between both. ⁽¹⁾

Legally, when it comes to food and nutrition in Brazil, the nutritionist is the professional qualified for this purpose, since the dietary prescription is his exclusive (Federal Nutrition Council [Conselho Federal de Nutrição - CFN]) ⁽²⁾. For that, there is an evaluation process for the prescription to be carried out and then nutritional monitoring.

Considering this whole process of evaluation and monitoring, as well as the relationship between nutrition and cognitive and emotional functions, it is believed that it is important for the nutritionist to understand the areas of neuropsychology. The knowledge of the neuropsychological assessment instruments that will assist in nutritional qualification and that will increase your daily practice is emphasized.

Thus, the objective of this article is to carry out a theoretical essay on the neuropsychological instruments used for the assessment of adults and the elderly, which can contribute to the nutritional assessment, specifying the cognitive functions evaluated and their relationship with the nutritional and emotional factors of the individual.

A brief survey of tests and neuropsychological tasks or that could be useful

in professional nutritionist work was carried out. It was verified not only the cognitive evaluation, but also the relationship between emotion and food. Thus, it is thought that this trial can become a basic guide for the clinical nutritionist.

METHOD

This theoretical essay is based on a review of the available scientific literature on neuropsychological instruments used for the assessment of adults and the elderly, to contribute to nutritional assessment, about the cognitive functions evaluated and their relationship with the individual's nutritional and emotional factors. The advanced online consultation was carried out in the databases: Scientific Electronic Library On-line (SciELO), and Latin American and Caribbean Literature in Health Sciences (LILACS) for the descriptors in Portuguese and PubMed for the corresponding descriptors in English, aiming to review the national and international collection on the researched theme.

The following subject descriptors in the list of Health Sciences Descriptors (DeCS) were used: "Nutrition", "Cognition", "Emotion" "Eating Behavior" "Neuropsychology", "Attention", "Memory", "Language" , "Executive function", and the same terms in English that exist in the list of descriptors from Medical Subject Headings (MeSH). The Boolean operator "AND" was used in the process of crossing the aforementioned descriptors. Finally, studies were found in the bibliography of the articles found, as well as through manual search. For the purpose of theoretical / historical background and deepening of the discussion, books, theses and official documents were also considered.

RESULTS**Assessment tools**

First, a quick contextualization of neuropsychology and cognitive functions, as well as the concepts of cognition and emotion, is done here. With this, a better understanding of the topic is expected.

Cognition, succinctly, is the way the brain perceives, learns, remembers and thinks about the stimuli captured from the environment and perceived by the senses. Act or process of acquiring knowledge that occurs through perception, attention, memory, reasoning, judgment, imagination, thought and language. It encompasses a set of mental processes used to classify, recognize and understand for judgment through reasoning for learning and problem solving, providing adaptation and interaction to the environment and other individuals making it unique. ⁽³⁾

Cognitive functions include the mental capacity to perform processes that involve perception, attention, memory, planning, language, physical and emotional behaviors captured from stimuli from the outside world through the senses and stored in memory. It is understood as the main cognitive functions: attention, memory, language and executive functions that will be deepened below ⁽³⁾ and are also related to nutritional factors and eating habits. ⁽⁴⁾⁽⁵⁾⁽⁶⁾

Several theories are used to define emotion. ⁽³⁾ Usually, emotion and feeling appear as synonyms, however, according to Damásio ⁽⁷⁾, the relationship between them is very narrow. Emotion consists of a set of reactions of the body, automatic and unconscious, which come from stimuli in the environment where the human being is inserted. When there is awareness of these emotions, then the feeling ari-

ses, that is, the feeling occurs when the emotions are transferred to the brain, where activation and coding occurs. In a broader context than the concept of emotion, conscious feelings, which are consciously accessible, coming from the set of emotions and feelings that involve other dimensions such as cognition, are understood as affects.⁽⁸⁾

By neuropsychology, it is defined as an area with an interface between psychology and neuroscience that studies cognitive, emotional and behavioral disorders, as well as personality disorders caused or enhanced by brain injuries or dysfunctions. These disorders can be caused by congenital formations or trauma. Of these traumas (emotional or mechanical), injuries or dysfunctions occur. Injury is understood to be direct damage to the brain tissue and, usually, abrupt, such as Cranium-Brain Injury. Dysfunction occurs over time, without necessarily causing damage to the brain parenchyma (psychological trauma, neurocognitive or mood disorders, for example). The dysfunction, over time / years can become an anatomical-functional lesion. A profound and recurrent depression, for example, can progress to dementia.⁽⁹⁾

Neuropsychology complements diagnoses and participates in and in clinical interventions aimed at alterations in the Central Nervous System (CNS), as well as in experimental and clinical research in the presence or absence of pathologies. Its objectives are to assist in the differential diagnosis of neurological and psychiatric disorders, to investigate the origin, the size of cognitive and behavioral changes, and to monitor their rehabilitation.⁽⁹⁾

Different professionals form the basis for the study of neuropsychology: speech therapists, psychologists, pedagogues, linguists, neurologists etc. Like the discipline, the science of nutrition is the study object of researchers and professionals from different fields of knowledge, being the nutritional prescription, and the whole process

involved, restricted to the nutritionist. To do so, to know and understand the complex aspects involved in the act of eating and nourishing the human being goes beyond food and nutrition issues and goes through sociology, anthropology, economics, psychology and neuroscience, among others. And it is in this transdisciplinary character that nutrition and neuropsychology meet and complement each other.

In addition, the health of cognition is linked to the health of the body as it goes through breaking the etiology of inflammation and infection, chronic stress, metabolic, cardiac and neurological changes and allergies.⁽¹⁰⁾ By promoting one, the other is promoted and, in this process, food is included.

A structured nutritional assessment for neuropsychological care requires the use of several instruments such as anamnesis that investigates anthropometry, eating and living habits, as well as emotional and cognitive prodromes.

Questionnaires, tests, scales, tasks, neuroimaging exams and neuropsychological tests help to identify potential losses and deficits resulting from life histories, and their impact on the individual's daily life, with the aim of promoting health by preventing losses or recovering and rehabilitating people. Daily Life Activities (ADLs)⁽⁹⁾⁽¹¹⁾, including those related to food and nutrition identified by demand or by the professional. Several tests are for the exclusive use of psychologists or speech therapists, who will be exposed later in Table 1 and highlighted with Ψ and F, respectively. This table summarizes the list of tests validated by the Psychological Test Assessment System (Sistema de Avaliação de Testes Psicológicos - SATEPSI) of the Federal Council of Psychology, as well as free access. Therefore, it is emphasized here the importance of the joint action of the different professionals in order to provide full monitoring to the individual.

The tasks consist of activities that can be clinical, elaborated by the pro-

fessional, or standardized based on scientific studies that can be used with knowledge in the area. In recent literature, standard task materials are available for use. The results obtained provide a qualitative assessment that complements the assessment.⁽¹²⁾

Neuropsychological tests (questionnaires, scales, inventories) carry out a quantitative assessment and, in a concrete way, show the individual preserved, impaired and possible improvement cognitive aspects.⁽¹¹⁾⁽¹³⁾ Although many evaluate more than a single function, Table 1 presents a summary of those most commonly used and the main cognitive functions addressed.

The relationship between food, cognition, food and emotion has been the target of several researchers in view of the role of dietary nutrients. In addition, the proper digestive process that occurs when respecting and stimulating the growth of beneficial bacterial flora also improves human cognition and emotion. Furthermore, it turns out that, in fact, it consists of a two-way route of the brain-intestine axis.⁽¹⁴⁾⁽¹⁵⁾

Executive functions are extensively studied, especially in relation to obesity and eating disorders. Changes in inhibitory control are associated with them. However, other cognitive functions must also be observed in nutritional assessment.⁽¹⁶⁾ Thus, cognitive functions will be presented didactically in subtitles and their respective tests for evaluation.

Attention

By definition, attention is the gateway to cognitive functions. Paying attention can be conceived as returning the perception to something, whether from the external or internal environment. There are different theoretical models used for a better understanding. Fuentes, Malloy-Diniz, Camargo e Cosenza⁽¹⁷⁾ use the model proposed by Posner⁽¹⁸⁾ where, in a succinct way, there are three subsystems in which it is divided:

- a) alert or vigil: related to the internal and external stimuli of the environment. Such as supermarket stimuli, colorful packaging and the organization of shelves, or the smell of a certain food, for example the smell of bread or something spoiled;
- b) guidance or automatic attentional processes: directing the focus. It needs the performance of sensory and processing resources as well as the baggage acquired as reading and counting. Expressed by eye and manual movements and expressive language. Related to the speed of execution of both simple and complex tasks. Example: selecting items to buy from the market, feeling the taste and texture of a certain food while chewing;
- c) executive attention or controlled attentional processes: related to the actual execution of tasks such as voluntarily changing the focus, fixing attention and resolving attentional conflicts in moments that require inhibition (whether or not to take a chocolate), flexibility (choosing the fruit), alternation (eating) in front of the TV).

Diamond⁽¹⁹⁾ reports that controlled attentional processes are closely linked to executive functions, especially inhibitory control.

To quantitatively assess attention, several tests can be used (Table 1), most of which are restricted to psychologists such as: Psychological Battery for Attention Assessment (BPA), Visual Selective Attention Scale (EASV), Visual Attention Test (TAVIS 4), Selective Attention Test (TAS), Attention Tests: Concentrated (TEACO-FF), Split (TEADI), Alternate (TEALD), Cancellation Test of the Bells. The Dot Prob Task, a computerized test,

although developed for anxiety and depression disorders, can also be used to assess eating disorders when adapted for eating. (20. Overduin, Jansen e Louwerse⁽²¹⁾ adapted the Stroop Test for food consumption.

Considered extremely important for all aspects of cognitive functioning, attentional resources are important predictors for learning and solving problems, from the simplest to the most complex, in all stages of development. In adulthood, these resources are available at full power and decline when following the timeline forming an inverted "U" curve. Attentional impairment at older ages may be related to cognitive decline.⁽¹⁷⁾

Attentional stimuli are launched at all times in the environment, including the choice of food in a simple trip to the supermarket, for example. The way in which the shelves are organized (non-perishable goods and ultra-processed foods in the first aisles and fruit and vegetable areas in the back), the making of packaging (colors, catch phrases), promotions (take 2 and pay 1) are used to attract consumer attention. Automatic attentional processes, especially ocular ones, are constantly required in these situations and this bias falls mainly on high calorie and low nutritional value foods for both men, regardless of hunger, and for women, regardless of hunger or BMI.⁽²²⁾

High calorie food images are also associated with an increase in the perception of pleasantness of their taste, which can influence food choices.⁽²³⁾ Assessments carried out through electroencephalogram examinations detecting Event-Related Potentials (ERP) that detects the start of an event as a sensory or motor stimulus show that less palatable foods receive less attention compared to those of greater palatability.⁽²⁴⁾

Motor impulsivity (acting before thinking) related to food can predict weight gain for those who demonstrate attentional bias for high-calorie foods.⁽²⁵⁾

Doolan, Breslin, Hanna, Murphy e Gallagher⁽²⁶⁾ discuss the different methodologies used to assess attentional bias in populations in order to measure food consumption and relate to the increase and maintenance of obesity. One of the most common tests to assess attentional bias in research is Stroop. In their modified form, words and images of food activate the reward system which could influence the test result since hunger levels, energy density of visual food signals and individual food-style characteristics can influence visual attention. It is known that there is no single model for research because obesity and other eating disorders are multifactorial and, therefore, need more research to create a standard.

In addition to obesity, other eating-related disorders may be associated with changes in selective attention, which may be a cause of subsequent food consumption. It is also important to consider the motivations and the influence of the environment by which they can impact attention.⁽²⁷⁾⁽²⁸⁾

Memory

Memory consists of the brain's ability to recall information that has occurred or felt. For this, it is necessary to acquire this information, form it, preserve it and evoke it when necessary. This process is closely related to learning, as the human being does what he knows. Based on the elaborated memories of the set of facts and emotions involved in the process, creating false memories, building his autobiography, the individual shapes his personality, his way of being and living, projects, chooses and decides his actions making him unique.⁽²⁹⁾

Learning and memory are two interrelated concepts. Learning depends on memory for its permanence. Memory would not have "content" if there were no learning. Learning is understood as the permanent change in behavior due to past experiences. While memory is the retention of a le-

arning or experience in order to enable its recovery.⁽¹⁷⁾

For better understanding, the memory is divided into two large groups: explicit (declarative) and implicit (non-declarative). Explicit (declarative) memory is divided into two types: operational and long-term. These, in turn, also branch out. Working memory, also known for short term, involves working memory. Long-term memory or declarative or explicit memory is subdivided into episodic and semantic. Working memory comprises the quick storage of information, such as memorizing the name of a culinary preparation and being responsible for sending the information deemed necessary for long-term memory. In long-term memory, declarative or explicit memory involves the storage and conscious recognition (recall) of facts and events (facts, names, concepts). Episodic memory makes it possible to remember facts that occurred in childhood, for example, being associated with "what". Semantics, on the other hand, is responsible for the association of objects with their respective names, for example, when talking about apple (meaning) we remember the red and rounded figure (sign). In it, the acquisition of the concept of knowledge - words, symbols, meanings - are not always remembered where and how they occurred. Semantic memory is closely linked to language.⁽¹⁷⁾

To memorize and learn there are two distinct thought processes: effort and automatic. Effortless thinking consists of the information entrance, acquiring material or coding (using selective attention) followed by storage and repetition, rescue or retrieval (through working memory) considered explicit or declarative memory. Automatic thinking, on the other hand, is acquired through training (repetition) of the same movements, such as walking, talking, eating as examples. Both processes go through a period of interaction, since the first

information acquired by the person is with effort, that is, the information is transmitted, coded by the receiver and stored, so that it can be repeated (like eating); consequently, the action becomes automatic, being transformed into implicit memory.⁽¹⁷⁾

There are also sensory memories: olfactory, tactile, gustatory, visual and auditory, which, when related to food, are fundamental for the construction of eating habits.

All types of memories enter the cortex through the senses and find their way into the brain, the precise place where the stimuli received depends on the type of information they contain and the emotions related to them. The beliefs that can generate conditioned and automated behaviors are part of the implicit memory.

Several tests can help the professional to check the memory in its different biases (Table 1) such as Hopkins Verbal Learning Test - Revised (HVL-T-R), Brief Visuospatial Memory Test - Revised (BVMT-R), Rivermead that are freely accessible. The other tests belong to the psychologist's performance, the most used being: Rey Complex Figures, Brief Neuropsychological Assessment Instrument - Neupsilin, Semantic Priming, Rey Auditory-Verbal Learning Test (RAVLT, acronym for Rey Auditory Verbal Learning Test).

Assessing memory can be a way of assessing the individual's perception and food choices. Martin, Davidson e McCrory⁽³⁰⁾ verify that the control of food intake in healthy adults and the ability to remember episodes that involve eating are associated with reduced episodic memory, leaving room for eating improperly. A deficient episodic memory is related to reduced perception of hunger and satiety and becomes a tendency to uncontrolled food, as well as working memory, since they are fundamental cognitive processes for decision-making related to food.⁽³¹⁾ Brunstrom et al.⁽³²⁾, corroborating the study described earlier, observed

that the feeling of hunger was lower in people who thought they had ingested greater volumes of food compared to those who actually consumed it within two to three hours after eating and after the next 24 hours.

If with an adult considered healthy, deficiencies of episodic memory are associated with perception of hunger and food choices, in obese individuals or other eating disorders it is thought that it could be a consequence. Zhang and Coppin⁽³³⁾ demonstrate that deficits in episodic and semantic memory impair food choices in terms of both quality, quantity and variety. The multifactorial cause of the condition is not excluded here, but they argue that, knowing how the individual's memory works, it can assist in conducting best rehabilitation practices. Furthermore, they refer to the need for further research on the role of semantic memory in eating habits.

The formation of memory is closely linked to emotions in view of the sum of experiences with food and eating habits. Smells, tastes, moments lived, expectations and beliefs formed in the construction of these habits and the individual's relationship with food, how these affects influence assessment methods related to memory, mood and food. Therefore, more research is needed to establish more accurate methods of assessing the triad: memory, mood and feeding.⁽³⁴⁾

Language

Language consists of a complex skill that uses all cognitive functions for its execution. It comprises the reception and decoding (verbal comprehension) of the stimuli of the environment including hearing and reading. It also comprises the coding of expression and production that includes speech, writing and signaling. The levels of the language representation comprise: semantic (meaning), phonetic (mechanics of sounds), phonological (distinction of speech sounds), morphological

(study of the part or word isolated from the context), lexical (comprehension and production of words), syntactic (sentence rules), pragmatic (language usage and interpretation and the variables between speaker and listener) and prosodic (production of affective or semantic meaning based on intonation, rhythm and elements that are not identified in writing).⁽³⁵⁾

The assessment of language starts at the first contact with the individual and, in the anamnesis, it is important to check the education and reading habits to observe the cognitive reserve which are directly related. Assessment tasks usually involve expression and understanding of words, phrases or speeches, the most commonly used tests being: Boston Naming Test, Semantic Verbal Fluency Test (animal category), Peabody Image Vocabulary Test, Tolken Test, Montreal Communication Assessment Battery (Protocole MEC), the Functional Assessment of Communication Skills for Adults (ASHA-Facs) and the Montreal-Toulouse Language Assessment Battery (MTL – Brazil). All free access. The NEUPSILIN Brief Neuropsycholinguistic Assessment Instrument, and in its form adapted for expressive aphasic patients, belongs exclusively to the use of speech therapists and psychologists. It should be noted that language also has non-linguistic characteristics regarding emotional content. In general terms grouped under the name "emotional prosody", which refer to the inflections of the voice, which are very important during the communicative process and the exchange of interpersonal information.⁽³⁶⁾⁽³⁷⁾

For the elaboration of language, several brain areas are required, which shows the importance of other cognitive functions for proper functioning and consequently the activation of brain regions that also cover areas of expression and understanding. Cognitive functions cannot be seen independently, there is always a complementary

or modular relationship between them. In relation to language, the importance of the attention and working memory functions and the central executive system are highlighted.⁽³⁶⁾⁽³⁷⁾

Working memory (working memory) consists of the ability to temporarily store a set of information for the performance of an activity, being a type of transient memory. It involves the temporary storage and manipulation of information that is considered necessary for a wide range of complex cognitive activities. Therefore, it is directly related to language acquisition and processing.⁽³⁶⁾⁽³⁷⁾

Several semantic stimuli are inserted in tests adapted for cognitive assessment of food consumption, as in the Modified Stroop. Discreet reduction in the amplitude of these stimuli in people potentially or diagnosed with anorexia, being a probable cause of the result of chronic hunger, can predict the development and / or maintenance of the disorder.⁽³⁸⁾ The slowness of language in identifying food and emotional stimuli may be indicative of alterations in selective attention in anorexics and bulimics.⁽³⁹⁾

Furthermore, in the course of the anamnesis, since the semantics and prosody have a strong connection with the affects related to life experiences, a methodology that can be used to help better understand how the individual expresses it is the Conversation Analysis (CA) or Speech-in-interaction (SII). This methodology, originating from sociology where Oliver Saks glimpsed the analytical possibilities of conversation (conversation analysis) and his interactions in daily life (speaking in interaction), investigates how in these interactions people build their identities and relationships in ways that are socially relevant.⁽⁴⁰⁾

Tapsel, Brenninger e Barnard⁽⁴¹⁾ describe the tool as a consistent way of reporting on eating habits and identifying characteristics in the conversation when addressing problematic

issues in food and nutrition among diabetic patients and health volunteers. The interaction and influence of family members on their children's food and nutrition education as well as on the perception of satiety and its psychological and social implications.⁽⁴²⁾

Mondada⁽⁴³⁾ analyzes the relationships established between people during the moments when they ate their meals with their eating habits and emotions related to the context.

The importance and practical applicability of CA in the field of food and nutrition are highlighted by Tapsel⁽⁴⁴⁾, which applies the methodology in a teaching environment to equip future professional nutritionists, for use in dialogues about eating habits and their maintenance in patients. Thompson, Blackshaw, Coulton, Albury e Tedstone⁽⁴⁵⁾ use the methodology to support the development of a guide to help health professionals talk about weight management with family members and children.

Executive functions

Executive functions comprise a set of skills that control the conscious, complex and non-automated cognitive processes of DLAs.

Executive functions comprise a set of skills that control the conscious, complex and non-automated cognitive processes of DLAs. In adversities such as stress, sadness, lack of sleep as well as in psychiatric disorders (depression, bipolarity, among others) and neurological conditions they are also the first to change or become deficient.⁽¹⁹⁾

Functions are thus named, as they are a set formed by Inhibitory Control (IC), Working Memory (WM) and Cognitive Flexibility (CF), these being the main ones and, often, they depend on each other. Inhibitory control works in conjunction with attention by filtering distracting stimuli, that is, the ability to regulate automatic behavioral responses, such as shopping at the supermarket or the amount of food

eaten. On a cognitive level, you control thoughts by keeping them in your goals, 'Am I hungry?'. Avoiding acting automatically or impulsively consists in the behavioral action of the inhibitory control, 'eating the first thing that appears'. Working memory, mentioned earlier, consists of short memory storing and manipulating information for quick use, such as constantly remembering food in different situations of the day. When there is a need to change perspectives, new behaviors and strategies, cognitive flexibility is the resource used by the brain, such as the acquisition of new attitudes and eating behaviors.⁽¹⁹⁾

There is a consensus among researchers where the set of the three forms the basis for the other executive functions that form the executive processes: decision making, planning and problem solving. Decision making relates to reward or avoidance processes and involves emotions or motivations, whether or not to change eating habits. Planning requires establishing objectives and questions such as: what, where, how, why guide the process. Problem solving leads to the achievement of the objective in its different solutions for this. Uses mental representation, planning, strategy implementation and monitoring.⁽¹⁹⁾ For example, in a buffet, mentally visualize the preparations that will be served by selecting what will be served, serving yourself observing if the execution agrees with the initial proposal.

With this, it is essential to know and evaluate the executive functions for nutritional monitoring. Tests such as Trails, Verbal Fluency, FAB Battery, Hayling's Impulsivity Scales, Rey's Complex Figure, Clock Drawing Test and Stroop are among the most common. The Stroop test has a modified version for food stimuli, Food Stroop.⁽²¹⁾

Executive functioning is involved in eating behavior. Therefore, it can be considered as a predictor of its self-regulation.⁽⁴⁾ Changes in this functioning correspond to higher

consumption of unhealthy foods and lower consumption of healthy foods in people of adequate weight. The decrease in IC is associated with a greater intake of saturated fats and the superior ability to control impulses and monitor the intake of fruits and vegetables.⁽⁴⁶⁾ Slow inhibitory control and obesity are also linked.⁽⁴⁷⁾

The fundamental importance of WM in the self-regulation of eating behavior consists of its performance in the maintenance and persistence of long-term goals in constant thinking⁽⁴⁾, as in the introduction and maintenance of new eating habits⁽⁵⁾. The better the WM's performance in initiating attitudes and behaviors, the better its maintenance capacity and the elimination of internal conflicts that may interfere in the process, as Allom e Mullan⁽⁴⁶⁾ found in people with higher consumption of fruits and vegetables. In addition, there is a direct association between performance of visuospatial memory (temporary memorization of information and creation and maintenance of mental images) and eating habits, given the greater ability to allocate attentional resources to the proposed objectives.⁽⁴⁾

The other components of executive functions also have a connection with food choices such as planning, cognitive flexibility and initiation. Skills most required when observing the external stimuli of the environment that favor excessive consumption of palatable food over healthy food.⁽⁶⁾ In other words, the diversion of selective attention to these more palatable and high-calorie foods.⁽²⁷⁾⁽⁴⁸⁾

Brain reward systems are more activated when compared to foods with higher levels of fats and refined carbohydrates to the detriment of those with a high content of complex carbohydrates, low fat and high protein value. The same occurs in comparison with vegetables.⁽⁴⁹⁾

Nijs, Franken e Muris⁽⁵⁰⁾ concluded that obese people tend to obser-

ve more stimuli related to food with improved preconscious processing, thus showing their greater sensitivity, especially when it comes to the obesogenic environment and the predisposition to overeat. This study was based on the Stroop test evaluating behavioral indices, verifying the reaction time, and electrophysiological of the individuals.

The Iowa Gambling Test (IGT) was used to verify obesity decision-making⁽⁵¹⁾ and binge eating disorders.⁽⁵²⁾ Røtge, Poitou, Fossati, Aron-Wisniewsky and Oppert⁽⁵¹⁾ point out that the ability to make decisions considered risky is impaired in this audience. However, Danner, Ouweland, van Haastert, Hornsveld and Ridder⁽⁵²⁾ demonstrated that both patients with binge eating disorder and other eating disorders have decision deficits and the lower the test performance, the greater the severity of the binge.

Meule⁽⁵³⁾ discusses the mechanisms of impulsivity on the Body Mass Index (BMI) where it highlights that the association between both consists of an indirect path, since the impulsive personality can influence positively or negatively. He argues that personality impulses can trigger increased food intake and, possibly, weight gain. In contrast, constructs such as extraversion and the search for new sensations correlate with greater physical activity, leading to a better BMI in view of the mechanism used to drive impulsivity.

There is a connection between cognition and emotion. Rauch, Hume, Howells, Kroff e Lambert⁽⁵⁴⁾ demonstrate that, even in individuals who have lost weight and maintained it for more than a year, the action of the nervous system located in the heart maintained the pattern of the period prior to weight loss when Food Stroop activities were performed. In addition, both people undergoing weight loss and those undergoing maintenance showed greater sensitivity to the stimuli related to food from the tests used, demon-

trating the relationship of an indirect path between stress as an inducer of the act of eating.

Emotions

Even though the mechanism between nutrition, cognition and emotion is still not fully understood, it is known that there is an influence of one on the other components of this triad. For example, emotions can trigger various behaviors, including eating.⁽¹⁾ Hence the importance of including the emotional question in the assessment, as they may be the main or secondary cause of food consumption.

People who, for some reason, have some difficulty in dealing with their emotions and get into psychological distress become candidates for developing mood disorders, with depression and anxiety being the most common. Otherwise, cognitive changes may cause these disorders as a comorbidity.⁽⁵⁵⁾

The Beck Depression Inventory (56) and the Depressive Thoughts Scale (Escala de Pensamentos Depressivos – EPD)⁽⁵⁷⁾ are instruments used by psychologists to assist in the diagnosis of both situations, as well as hopelessness and suicidal ideation. With free access, the Geriatric Depression Scale – GDS15⁽⁵⁸⁾, specific for the elderly, and the Self-Reporting Questionnaire - SRQ-20⁽⁵⁹⁾ assess mental suffering and screen for possible mood disorders. Even if they do not provide a diagnosis, they show important indications for better management of the therapeutic process.

Assessment of eating behavior

There are several instruments for food and nutrition assessment that, together with anthropometry and clinical / laboratory exams, are part of the framework of basic tools of the nutritionist and traditionally applied in anamnesis consultation. Fisberg, Marchionni e Colucci⁽⁶⁰⁾ briefly summarized the advantages and disadvantages of these instruments. These can be elab-

orated by each professional adapting their practice or using those already validated by the literature.

Basically, according to their objectives, they are divided into three groups: quantitative assessment of intake as a 24-hour food record and daily or food record; assessment of the consumption of foods or food groups that consists of the food frequency questionnaire and, finally, the assessment of the dietary pattern through food history. To Zuniga e Mcauley⁽⁶¹⁾, it is essential to observe the influence of cognition on dietary assessment and consider the need to adapt the instruments to the target audience.

For this purpose, eating behavior is a way of expressing cognition and related affects that go beyond the act of eating and nourishing. Kotait, Barrillari and Conti⁽⁶²⁾ verify that there are specific instruments for assessing emotional and mental states both in populations and individuals and reinforce the need for professionals to observe the context in which their target audience is inserted. The authors discuss: Eating Attitudes Test, Bulimic Investigatory Test Edinburg, Binge Eating Scale, Eating Behaviors and Body Image Test and Restraint Scale, their objectives of use and provide these instruments in the appendix.

The Three Factor Eating Questionnaire (TFEQ) used to evaluate both clinically and to conduct research as an isolated instrument⁽⁶³⁾ as in conjunction with other tools⁽⁴⁸⁾⁽⁵⁴⁾ about emotional and cognitive factors related to food, being considered a great indicator of weight gain in the long term and a milestone for the inclusion of new strategies for food and nutrition guidance. Seage and Lee⁽⁴⁸⁾ observed a prediction of an increase in attentional bias for high-calorie stimuli included in the questionnaire. In its reduced form (TFEQ-R21), it was translated and validated for Brazil by Natacci and Ferreira Júnior⁽⁶³⁾, which consists of 21 questions divided into three major

groups: cognitive restriction, emotional eating and uncontrolled eating.

The food industry has used several questionnaires in order to know consumer preferences and develop new products. These instruments, in addition to the sensory characteristics of food, are designed to verify the emotions evoked by food. Kaneko, Toet, Brouwer, Kallen and van Erp⁽⁶⁴⁾, in a systematic review of 101 articles in English on the subject, they selected instruments in two large groups: measurement (physiological, cognitive and behavioral) and emotional processing (sensory unconscious, early perception / cognition and conscious / decision making). When categorized with each other, they show diversity and for what purposes they can be used, ranging from imaging exams, observation of body microexpressions to questionnaires and scales. Many of these instruments have not yet been validated in Brazil. An example of validation for the Brazilian industry consists of the questionnaire on the impact of cognitive and behavioral factors that affect the acceptance of functional foods.⁽⁶⁵⁾

CONCLUSION

Assessing the person from the perspective of cognition and emotion, going beyond food consumption, clinical laboratory tests and anthropometry as well as socio-cultural aspects, raises the level of performance of the nutritionist professional when understanding neuropsychological assessment can point out the how and why of behaviors that refer to eating habits.

The conceptual review highlights that the person does not need to have a pathological condition to use instruments to understand eating habits and behaviors. Given this, it can assist food and nutritional rehabilitation and re-education and, consequently, achieve or maintain goals adjusted as appropriate in agreement with the individual himself. For neuropsychological instru-

ments can act as a metric of the individual's situation and evolution.

The evaluation process is a constant in professional practice, since its application makes it possible to measure and qualify the actions of dietary planning and monitoring. Furthermore, even though there is no gold standard for this, the use of instruments can contribute to future research in the area.

The findings demonstrate that com-

binning nutrition with neuropsychology can increase the nutritionist's understanding of a more global and more effective action on human beings. The researches listed in the framework point to relevant improvement in aspects such as: paying attention to yourself, your needs and desires to learn, elaborate, use and reframe eating and life habits, helping and basing the best choices appropriate for your well-being.

It is suggested to think about the brain-heart-intestine route in addition to those already mentioned in the literature: brain-intestine and brain-heart. Along this path, the nutritionist, in possession of neuropsychological instruments, is able to comprehensively understand the behavioral and motivational developments inherent to the change and maintenance of dietary and health care routines. ■

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ANNEX A

Table 1. Summary of neuropsychological tests and respective cognitive domains assessed

TESTES	AT	MEM	LIN	FE
Atenção Concentrada (AC) Ψ	X			
Atenção Concentrada (AC15) Ψ	X			
Avaliação Funcionas das Habilidades de Comunicação para Adultos (ASHA-FACS)			X	
Bastões de Goldstein		X		X
Bateria MAC			X	
Bateria Psicológica para Avaliação da Atenção (BPA) Ψ	X			

Bender Gestáltico	X	X		X	
Blocos de Corsi		X		X	
BRIEF				X	
Brief Visuospatial Memory Test – Revised		X			
California Verbal Learning Test-II (CVLT-II)		X	X		
D2 Ψ	X				
Escalas de Impulsividade de Hayling				X	
Escalas Wechsler de Memória Ψ		X			
Escala de Atenção Seletiva Visual – EASV Ψ	X				
Frontal Assesment Batery – FAB				X	
Figuras Complexas de Rey Ψ		X		X	
Fluência Verbal			X	X	
Hopkins Verbal Learning Test – Revised		X			
Instrumento de Avaliação Neuropsicológica Breve – Neupsilin Ψ	X	X	X	X	
Iowa Gambling Test		X		X	
Bateria Montreal-Toulouse de Avaliação da Linguagem			X		
Priming semântico		X			
Prova de Ritmo		X			
Questionários de memória (MAC-Q e MAC-SV)		X			
Repetição de Pseudo-palavras		X			
Rivermead		X			
Stroop de Cores Ψ	X			X	
Teste de Atenção Visual (TAVIS 4) Ψ	X			X	
Teste de Aprendizagem Auditivo-Verbal de REY Ψ	X	X			
Teste de Atenção Seletiva – TAS Ψ	X				
Teste de Boston para Diagnóstico de Afasias F			X		
Teste de Classificação de Cartas Wisconsin Ψ				X	
Teste de Memória Visual – TMV		X			
Teste de Nomeação de Boston	X				
	TESTES	AT	MEM	LIN	FE
Teste de Retenção Visual de Benton			X		
Teste de Trilhas Coloridas Ψ					X
Teste do Desenho do Relógio (FDR)					X
Teste dos Sinos	X				
Teste de Wisconsin de Classificação de Cartas Ψ					X
Testes das Pirâmides e Palmeiras				X	
Testes de Atenção: Concentrada (TEACO), Dividida (TEADI), Alternada (TEALD) Ψ	X				
Token Test				X	
Torre de Hanói			X		X
Torre de Londres					X

Note: AT (attention), MEM (memory), LIN (language), FE (executive functions). Adapted from "A Compendium of Neuropsychological Tests: Administration, Norms, and Commentary" by E. Strauss, E. M. S. Sherman, O. Spreen, 2006.