v. 5, n. 8, 2025

International Journal of Human Sciences Research

BEHAVIORAL PATTERN IN THE APPLICATION OF NEUROBEHAVIORAL CONCEPTS

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Acceptance date: 07/05/2025

Abstract: In the field of neuroscience, few terms carry as much weight as "neurobehavioral". It's a word that encapsulates the complex relationship between our brains and our behaviors. As we browse through this article, we'll dive deep into the mysteries and revelations of neurobehavioral, illuminating how our neurological processes shape our actions and reactions. Increasingly, neuropsychological rehabilitation and cognitive-behavioral psychotherapy are sharing common characteristics. This paper presents a model of the interface between these two approaches to therapeutic interventions. The model is based on mechanisms of neural plasticity and describes strategies related to detailed neuropsychological assessment of neurocognitive-behavioral functioning.
Keywords: Behavior. Neuro. Neurocognitive.

INTRODUCTION

The aim of this paper is to portray the relationships between the interventions practiced in cognitive-behavioral therapy, neuropsychological rehabilitation and neurosciences, describing a proposed model called neurocognitive-behavioral psychotherapy.

Clinical observations demonstrate the need to study the theoretical interface between neuroscience and psychology. Neurological diseases, such as frontal dementia and temporal lobe epilepsy, cause direct disturbances in cognition and affective and behavioral manifestations. Neurological alterations with a direct impact on cognition can secondarily affect the patient's mood and affective life, especially when the neurological condition has a significant impact on activities of daily living. Another important aspect to be highlighted is dysfunctional behavioral, cognitive and emotional patterns (depression, anxiety disorder, among others) due to experiences throughout life history that can have an impact on the development of neural connection patterns (Fichman-Charchat, 2003; Charchat-Fichman, 2006).

There are certainly neural circuits responsible for the most diverse mental functions, such as emotions, cognitions and behaviors. In this way, psychological constructions, even those that are dysfunctional and cause psychopathologies, are based on the relationships between the social environment in which the individual finds themselves and the neural circuits responsible for their mental activity (Kandel, Schawartz, & Jessel, 1995). From this perspective, it is known that therapeutic interventions (psychotherapy and rehabilitation) can cooperate effectively to regulate and even eliminate psychopathologies, through structural and functional modification of the central nervous system (Kumari, 2006; Linden, 2006).

BRIEF HISTORY OF THE MIND-BRAIN RELATIONSHIP

Neuropsychology studies mental functioning and its relationship with the brain. It has its roots in cognitive psychology which, by developing conceptual models of the functioning of the healthy mind, understands the various pathological expressions of these functions. The other area of influence of neuropsychology is behavioral neurology which, by studying clinical cases of neurological patients, unlocks the secrets of the mind-brain interface. The emphasis in this model is on understanding the organization of the central nervous system (Oliveira, 2006). The development of basic research in neuropsychology and behavioral neuroscience has produced knowledge about the patterns of psychological alteration in neurological and psychiatric diseases, as well as enabling the development of experimental paradigms and validated tests that make it possible to measure cognitive performance. In this context, the general aim of the clinical activity is to assess these functions and to plan and implement procedures that can add some therapeutic value to the pathological expression of these functions.

As far as the study of the relationship between neural structure and mental function is concerned, there has been an alternation throughout history between localizationism - localization of specific mental functions in circumscribed areas of the brain - and holism - each mental function has the brain as a whole as its substrate (Castro & Landeira--Fernandez, 2001; 2011; Kristensen, Almeida, & Gomes, 2001). For example, in the 18th and 19th centuries, phrenologists localized more than 35 functions in the brain, such as maternal love and generosity. The strict localizationism of the phrenologists was challenged by other anti-localizationist perspectives, based on the holistic functioning of the brain, i.e. all regions of the brain were involved indiscriminately with any and all mental functions.

In the mid-19th century, Broca and Wernicke identified two regions of the brain responsible, respectively, for producing and understanding speech, as a result of their studies of the behavior and brains of patients with neurological problems. These discoveries inaugurated the return to a localizationist perspective, which developed throughout the 19th and 20th centuries and continues to this day. In this modern localizationism, elementary functions are localized in delimited areas of the brain, while complex functions are made possible by sets of brain areas, each contributing in a specific way (Fuentes, Malloy-Diniz, Camargo, & Cosenza, 2007; Luria, 1966, 1973; Oliveira, 2006).

NEUROPLASTICITY: THE BASIS OF THE PSYCHOTHERAPEUTIC INTERVENTION PROCESS

Neural plasticity, one of the most important characteristics of the central nervous system, provides certain capabilities, such as: (a) adaptation to changes in the environment; (b) storage of new information associated with learning; (c) reorganization of neural circuits in response to environmental stimulation: and (d) recovery from injuries to the brain and spinal cord (Johnston, 2009). The mechanisms involved in neuroplasticity include neurogenesis, cell death programming and activity-dependent synapses. Clinical examples of adaptive neuroplasticity include the reorganization of the cortical maps of the fingers in response to practicing an instrument, as well as the facilitated learning of a foreign language or sport by a child compared to adults. The structural changes occurring in the brain are shown in functional neuroimaging studies (Johnston, 2009).

These mechanisms of neural plasticity explain the impact of psychotherapy and cognitive rehabilitation (Johnston, 2009). They can be used to adapt and reorganize brain structures and functions. Therefore, the environment (in this case referring to interventions) is necessary for neural modulation and modification. Psychotherapeutic and rehabilitation techniques enable the perception of experiences, as well as practice and repeated stimulation (Duffau, 2006; Robertson & Murre, 1999). They facilitate the phenomenon of neural plasticity, promoting the strengthening of a skill or task, which stimulates a specific neural circuit to the detriment of inhibiting others (Duffau, 2006).

Neuroimaging studies corroborate this idea, showing that the reactivation of neural structures is induced by mental imagery, behavioral observation or passive training in patients with neurological and psychia-

tric problems (Duffau, 2006). In other words, cognitive and behavioral processes alter biological processes during rehabilitation and psychotherapy (Robertson & Murre, 1999). These recent neuroscience findings highlight the close interface between cognition, behavior, emotion and the brain.

Among the types of plasticity are regeneration and axonal, dendritic, somatic and synaptic plasticity. Synaptic plasticity refers to the change in the strength of neurotransmission induced by synaptic connections made in the past (Johnston, 2009). According to Andrade and Junior (2005), this type of plasticity is associated with learning. Consequently, it is the neuroplasticity mechanism most discussed when thinking about therapeutic interventions. These interventions are based on the construction of new learned behavioral repertoires and the formation of new memories.

Studies using functional and structural neuroimaging with patients suffering from anxiety disorders, such as post-traumatic stress disorder (PTSD), specific phobias, social anxiety, obsessive-compulsive disorder and mood disorders, have shown how psychotherapy can produce therapeutic effects through changes in certain neural circuits (Callegaro& Landeira-Fernandez, 2007; Cruz & Landeira-Fernandez, 2007; Etkin& Wagner, 2007; Porto et al., 2006).

Studies have even shown a pattern of brain functioning common to some anxiety disorders, highlighting greater activation of the amygdala and insula associated with negative emotions and fear (Landeira-Fernandez, 2011). Etkin and Wager (2007), for example, carried out a meta-analysis study in which they observed these aspects. According to Paulus and Stein (2006), the insular cortex is related to learning aversive responses, which could explain this insula activation, while the amygdala is related to danger activation, which would explain the association with fear and anxiety responses. Individuals with anxiety disorders have an exaggerated dysfunctional fear response to situations learned and conditioned throughout their lives, which justifies the greater activation of this neural circuit.

The same effect on the amygdala was observed by Goossens, Sunaert, Peeters, Griez, and Schruers (2007). Using a treatment based on exposure techniques for phobia, these authors found that cognitive-behavioral therapy was able to alter the activity of the amygdala and insula, as well as reducing anxiety scores. By reducing anxiety symptoms through learning mechanisms and ways of interacting with the environment, psychotherapy could be modifying and modulating the activation of these limbic structures.

Not only anxiety disorders have been studied from this perspective. For example, Kumari (2006) published data on mood disorders. In a review of the literature, the author showed that patients with mood disorders modified their activation of frontal and temporal lobe structures through interpersonal therapy and cognitive-behavioral therapy. Del-Ben (2005) also describes, based on a history of the biological bases of social behavior and a review of neuroimaging studies and neurotransmitter systems, the association of antisocial behavior with frontal areas (ventromedial portions) and the amygdala. These reviews point out that, among the therapies analyzed, cognitive-behavioral therapy promoted neural changes as consistently as pharmacology and also demonstrated the same efficacy in symptom remission. Linden (2006) reinforces these results in his review of functional neuroimaging studies on the effects of psychotherapy, evaluating the possible changes that have occurred.

These data highlight that neural structures are associated with the activation and regulation of emotional processes. In addition, they show that these neural mechanisms be-

come dysfunctional in psychiatric disorders, as do the psychic constructions consistent with each disorder. Finally, the main studies on neuroscience and psychotherapy seek to test the effectiveness of psychotherapies in altering these structures and their functioning, promoting some therapeutic gain in the face of these disorders. Among these studies, psychotherapy is the one that has been studied the most and found, in some cases, to be equivalent in effectiveness to psychopharmacotherapy and cognitive-behavioral therapy.

THEORIES UNDERPINNING THE NEUROCOGNITIVE-BEHAVIORAL INTERVENTION MODEL

The theoretical references that are used during the neuropsychological assessment, psychotherapy and rehabilitation process are based on: (a) cognitive neuropsychology; (b) cognitive psychology, based on the information processing model; (c) behavioral psychology, based on theories of learning and experimental behavior analysis (Charchat-Fichman, 2006; Wilson, 1999).

Cognitive neuropsychology understands the relationship between cognitive disorders and the neural circuits involved. It portrays impaired and preserved cognitive functions and thus aids the diagnosis of neurological and psychiatric diseases (Lezak, 1995).

Cognitive psychology consists of a theoretical framework that conceives of the human mind as an information processor, offering resources for dealing with the most diverse conditions present in the environment (Sternberg, 2000). By developing experiments with healthy individuals, cognitive psychology proposes models of human cognitive functioning, thus enabling the identification of cognitive functions that can be rehabilitated, and defines the methodology for training or compensating for neuropsychological difficulties.

The purpose of behavioral psychology is to develop a functional analysis of the contingencies that regulate the patient's behavior and to map the impact of cognitive alterations on activities of daily living and the specific psychosocial context in which the patient is inserted. In addition, behavioral psychology gave rise to cognitive-behavioral psychotherapy, which offers intervention techniques for developing a new, more adaptive behavioral and cognitive repertoire that minimizes the effects of cognitive disorders on patients' daily lives (Charchat-Fichman, 2006; Rangé, 1995).

NEUROCOGNITIVE-BEHAVIORAL INTERVENTION MODEL PROCEDURES

NEUROPSYCHOLOGICAL ASSESSMENT

The first stage of the neurocognitive-behavioral intervention process is the neuropsychological assessment, which aims to formulate a profile of the psychological functioning of patients who have suffered brain injuries of various etiologies or have cognitive and behavioral alterations that can be attributed to functional alterations in the central nervous system. The assessment is conducted through interviews, free sessions and batteries of structured tests - which can be fixed or flexible, depending on the purpose of the assessment. It may also be necessary to plan specific tasks when an assessment with formal tests is not possible. This methodology makes it possible to draw up a profile of psychological functioning, with special emphasis on cognitive aspects, and to understand the role of emotional, environmental and neurological variables in shaping this profile, in order to formulate a diagnostic hypothesis that will result in a therapeutic indication (Lezak, 1995; Weintraub, 2000). One of these interventions will consist of designing specific rehabilitation programs

for each case, with the aim of re-establishing compromised functions or compensating for them (Fuentes et al., 2007; Rufo-Campos, 2006).

NEUROPSYCHOLOGICAL REHABILITATION

Neuropsychological rehabilitation is the therapeutic process that aims to enable patients with neurological dysfunction to adapt to their new psychosocial context (family, school, profession, occupation, instrumental and basic activities of daily living) (Kertesz, 1993; Wilson, 1999). The two principles that guide the practice of neuropsychological rehabilitation are: (a) recovery and (b) compensation (Wilson, 1999). The purpose of recovery is to train the impaired cognitive function, while the purpose of compensation is to teach alternative ways of performing activities that depend on the impaired cognitive function, or to maximize the use of preserved cognitive functions or, finally, to provide environmental restructuring. These two principles can occur sequentially or combined in a rehabilitation program. The rehabilitation program is more comprehensive than simple cognitive training, and the emotional, social and environmental aspects contribute significantly to the success of this therapeutic intervention (Charchat-Fichman, 2006).

COGNITIVE-BEHAVIORAL THERAPY

Cognitive-behavioral therapy brings together intervention techniques for cognitions, behaviors and emotions. In this therapeutic model, beliefs (core beliefs and automatic thoughts), emotional reactions and behavioral responses are interconnected and intervention on any of them also promotes changes in the others (Araújo & Shinohara, 2002; Beck, 1993; Knapp, 2004; Rangé, 1995).

The model of psychopathology based on cognitive-behavioral therapy involves the individual's dysfunctional evaluations and interpretations of situations and the environment in general. As a result, a stimulus activates the individual's way of functioning. This mode of functioning includes what the individual believes, the emotions associated with these beliefs and the behavioral patterns learned to deal with this cognitive-emotional structure. Therapy seeks to modify these established patterns through behavioral, experiential and cognitive techniques to develop new behaviors, self-regulate emotions and re-evaluate situations (Beck, 1993; Rangé, 1995).

Examples of these techniques include: exposure therapy, which is widely used for various anxiety disorders, self-instruction, problem-solving, distraction, conditioned reinforcement and stimulus control, monitoring and raising awareness of one's own difficulties, as well as restructuring cognitions and re-evaluating one's own interpretations (Rangé, 1995).

In behavioral exposure, the patient is placed in a situation with which they have difficulty coping, which is done gradually. This technique gives them the chance to evaluate and test the real consequences they expect, for example, from a social situation, from being in public, from facing an obsessive thought, or from any other anxiogenic situation. With exposure, they can realize that these imagined consequences are often irrational and may or may not occur, which encourages new learning about the expected danger and thus leads to the extinction of a previously conditioned fear. There is therefore a reinforcement of other possible consequences in addition to those previously learned. Another important technique is pre-exposure visualization and dramatization. Rainville, Hofbauer, Bushnell, Duncan, and Price (2002) show in their study that visualization promotes neurophysiological changes.

In the self-instruction technique, behaviour is guided by external speech until it is internalized. It is a model based on Luria and Vygostski (Souza & Ingberman, 2000). The problem-solving technique involves identifying the problem, developing possible solutions, evaluating the consequences of these solutions, implementing one of the alternatives and monitoring the results. This is done through step-by-step instructions. Cognitive therapy also uses techniques to raise awareness of difficulties, such as recording automatic thoughts related to negative emotions, which helps to monitor one's own thoughts. With this, the automatism of these thoughts gives way to controlled attention, in which the subject needs to understand what they are thinking and not react in the usual way to the situations with which they are involved (Araújo & Shinohara, 2002; Beck, 1993; Knapp, 2004; Rangé, 1995).

STAGES OF THE NEUROCOGNITIVE-BEHAVIORAL INTERVENTION PROCESS

In the neurocognitive-behavioral intervention model, a comprehensive neuropsychological assessment is initially conducted, which includes the following steps:

> a) Interview with patient, family and caregivers.b) Interaction activities with the patient (games, informal conversations, film analysis, task proposals).c) Behavioral scales.d) Standardized and validated neuropsychological tests (paper and computer).e) Neuropsychological profiling.f) Development of a functional diagnostic hypothesis based on cognitive and behavioral assessment.g) Development of a neuropsychological rehabilitation program that includes cognitive training, functional analysis, self-awareness and application of cognitive-behavioral psychotherapy techniques (Araújo & Shinohara, 2002; Beck, 1993; Knapp, 2004; Rangé, 1995).

Neuropsychological assessment provides a detailed understanding of the patient's neurocognitive-behavioral functioning and is therefore a fundamental condition for developing effective psychological intervention strategies.

The second stage consists of guidance and psychoeducation for family members and other individuals who live directly with the patient (school, professional environment, other health professionals). In this stage, the therapist holds a few initial sessions with the aim of presenting the patient's clinical condition to the family members and teaching strategies for cognitive stimulation and compensation in the natural environment, as well as helping with different difficulties in the adaptation process. This stage includes a visit to the patient's school, work environment or other important social space. This orientation process takes place during the intervention, at least once a month, to maintain the strategies developed and create new ones as the patient evolves.

The third stage is cognitive training. In this phase, techniques are developed to stimulate impaired neuropsychological functions and to develop alternative ways of performing tasks using preserved neuropsychological functions.

The fourth stage involves the application of cognitive-behavioral techniques to change to a psychosocial repertoire that is more adaptive to the patient's new condition. The patient must learn to control the side effects of anxiety and mood swings. The process of becoming self-aware of the contingencies that control their behavior is fundamental in this phase of treatment.

Most of the time, the third and fourth stages take place simultaneously in one or two weekly sessions. In addition to the activities in the clinic, the patient carries out activities at home, guided by family members or psychology trainees. Various psychopathological

conditions benefit from this type of combined intervention. The following briefly explains the possibilities of the stages of neurocognitive intervention in 3 clinical conditions: Invasive Disorders, Attention Deficit Hyperactivity Disorder (ADHD) and dementias.

Invasive Developmental Disorders, for example, emphasize deficits in social reading. These deficits are also associated with impairments in executive functions (EF) (Ozonoff, Strayer, Mcmahon, &Filloux, 1994). According to the neurocognitive-behavioural approach, intervention would take place through: (1) rehabilitation of these functions through specific exercises, such as organizing stories with a beginning, middle and end, understanding scenes in films to stimulate perceptual organization and the generation of hypotheses about the other person's behaviour (3rd stage) and (2) the use of a psychotherapeutic approach involving the development of social skills, especially empathic skills, aimed at the patient's everyday situations (4th stage).

Attention Deficit Hyperactivity Disorder, on the other hand, is defined as involving attention difficulties, impulsivity, behavioral inhibition and significant functional impairments, including social impairments (difficulties in self-regulation, accurate assessment of behavior and flexibility of responses). Likewise, one of the most relevant aspects of this condition is the impairment of executive functions (Capovilla, Assef, & Cozza, 2007; Semrud-Clikeman, 2007). In this case, treatment would take place through (1) stimulation of executive functions - which may involve training in planning, flexibility, inhibitory control and more precise observation of social situations - through playful activities such as, for example, building a comic book, planning a birthday party, or identifying the main ideas of a text or image (stage 3); (2) associated with cognitive-behavioral interventions (stage 4), which prioritize self-regulation, such as self-instruction to regulate impulsivity and evaluate the consequences of one's own behaviors; problem-solving, with the aim of developing more appropriate social strategies; as well as anxiety management when there is a comorbidity.

In dementias, this can be combined with stimulation of compromised functions and interventions with anxiety and mood management techniques, since depression is often comorbid with these conditions. Techniques aimed at reorganizing the routine and introducing pleasurable activities are therefore effective. Another way is to combine these techniques with stages of the stimulation itself, such as setting a rehabilitation goal of writing a book. This goal includes cognitive stimulation, as well as creating new perspectives and bringing pleasure and well-being to the patient.

Finally, psychotherapeutic interventions can be used for comorbidities, such as anxiety or low mood disorders. Or they can be more closely related, i.e. psychotherapeutic intervention and cognitive rehabilitation are concomitant and intertwined during the course of treatment. In these cases, many cognitive-behavioral techniques are also forms of cognitive stimulation, such as the problem--solving technique, which stimulates executive functions (planning, monitoring, hypothesis-building); or even the development of empathic social skills, which stimulates the construction of hypotheses about the other person's behavior. And, in turn, precise cognitive stimulation, i.e. in the functions associated with behavioral deficits, makes the patient better able to receive and use cognitive-behavioral techniques. Thus, there is a two-way relationship between them.

Thus, in some cases, stimulation can be done through cognitive training associated with psychotherapy; in others, psychotherapy itself and daily activities would be enough to

promote cognitive and emotional development, if the intervention is always guided by a precise assessment of the deficits that generate the behavioral changes. These relationships between cognitive-behavioral psychotherapy techniques and rehabilitation constitute the neurocognitive-behavioral model.

FINAL CONSIDERATIONS

Understanding behavior, functions and brain-mind organization is a long-standing quest and one that is still being pursued in scientific circles today. Over time, this relationship between neural structure and mental function has alternated between localizationism (specific functions are localized in circumscribed areas of the brain) and holism (function has the brain as its substrate).

Neurocognitive-behavioral psychotherapy proposes an intervention methodology based on the interface between cognitive psychology and neuroscience. This clinical practice has been used in different psychiatric disorders and neurological diseases. Clinical models of assessment and intervention are being proposed for cases of attention deficit disorder, Asperger's syndrome, bipolar disorder, mild cognitive impairment in aging, Alzheimer's disease, Parkinson's disease, head trauma and stroke, among others.Thus, the neurocognitive-behavioral intervention model follows such procedures: neuropsychological assessment - "aims to formulate a profile of the psychological functioning of patients who have suffered brain damage of various etiologies or have cognitive and behavioral alterations that can be attributed to functional alterations in the central nervous system." Thus, the neurocognitive-behavioral intervention model follows such procedures: neuropsychological assessment - "aims to formulate a profile of the psychological functioning of patients who have suffered brain injuries of various etiologies or have cognitive and behavioral alterations that can be attributed to functional alterations of the central nervous system". Therefore, neurocognitive-behavioral psychotherapy is a clinical practice that proposes an intervention methodology that uses the interface between neuroscience and cognitive psychology and can be used for different cases.

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