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Comparative structure of similarities and differences between tree and cognitive model of Cognitive Behavioral Theory

Estrutura comparativa de semelhanças e diferenças entre árvore e modelo cognitivo da Teoria Cognitivo-Comportamental

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Abstract

Objective

To contribute to studies in Psychology through a systematic and methodological analysis of the comparison between a tree and the cognitive model of the cognitive behavioral theory, establishing similarities and differences between the comparative domains.

Method

It is a qualitative, exploratory, documentary research, based on the Conceptual Metaphor, the Cognitive-Behavioral Theory, and on the Methodology of Teaching with Analogies. It starts from the hypothesis of the existence of a conceptual metaphor in which “the cognitive model is structured like a tree”, transposing characteristics between both. It verifies, classifies, analyzes the comparison by means of analogical reasoning and the filling of comparative charts between vehicle and target.

Results

The results point to the complexity and potential of comparison if treated systematically and methodologically.

Conclusion

The research results corroborate the hypothesis that originated it.

Keywords: Cognitive behavioral therapy; Cognitive psychology; Metaphor.

Resumo

Objetivo

Contribuir para estudos em Psicologia por meio da análise sistemática e metodológica da comparação entre uma árvore e o modelo cognitivo da Teoria Cognitivo-Comportamental, estabelecendo semelhanças e diferenças entre os domínios comparativos.

Método

A pesquisa é qualitativa, exploratória, documental, fundamentada na *Metáfora Conceptual*, na *Teoria Cognitivo-Comportamental* e na *Metodologia de Ensino com Analogias* e parte da hipótese da existência de uma metáfora conceptual em que “o modelo cognitivo se estrutura como uma árvore”; transpondo características entre ambos. Verifica-se, classifica-se e analisa-se a comparação por meio de raciocínio analógico e do preenchimento de quadros comparativos entre veículo e alvo.

Resultados

Os resultados apontam a complexidade e o potencial da comparação, caso seja tratada sistemática e metodologicamente.

Conclusão

A hipótese de pesquisa é corroborada.

Palavras-chave: *Terapia cognitivo-comportamental; Psicologia cognitiva; Metáfora.*

Analogies and metaphors (A&Ms) are resources used when comparing two “distinct things” to clarify one of them. Treagust et al. (1992) use the term “domain” to designate the “distinct things” being compared. Initially considered figures of speech with aesthetic and poetic functions, today A&Ms have a recognized role in human cognition, helping to understand the new, establish ideas, create, discover, especially if treated methodologically.

In Clinical Psychology, A&Ms, especially metaphors, are noted for their power of communication, helping patients to expose feelings, ideas, and perceptions. Furthermore, psychological approaches use analogies and metaphors in their theories when clarifying concepts, which makes them likely to be known and employed by Psychologists, for whatever the purpose, which raises the need to analyze them more deeply. Despite being relevant and frequent, research on metaphors were not common in Psychology 20 years ago (Moser, 2000). Nowadays in Brazil, a search in the *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (Capes) portal using the descriptors Psychology + metaphor revealed 6024 references, while the number for the descriptors Psychology + analogy was 4066. In the Scientific Electronic Library Online (SciELO) portal, the numbers for Psychology + metaphor are zero for titles and 17 for abstracts, and for Psychology + analogy we found zero titles and 12 abstracts. The search did not indicate in which of the references A&Ms were central themes.

The Cognitive-Behavioral Theory (CBT) “integrates concepts and techniques from cognitive and behavioral approaches” and aims to “understand the function and structure of cognitive aspects, which would be individuals’ ability to assign meanings to their experiences” (Soares et al., 2020, p. 100). “Considered by many as the main cognitive theory of today” (Reyes & Fermann, 2017, p. 49), it is anchored in the cognitive model that points out that behaviors are influenced by beliefs. Mathieson et al. (2020) point out, in CBT, that the number of research on metaphors is small, and there are no studies aimed at contributing to the training of behavioral therapists in the ability to work with them. The authors make no reference to the existence of studies that analyze A&Ms related to the theory of CBT. Analyzing A&Ms of a theoretical field can open possibilities to better understand a theory.

In general, referring to the cognitive model, psychologists refer to a comparison between this and a tree, as establishing similarities between such domains (cognitive model and tree) would make it easier to understand how beliefs are structured. The term tree, throughout this text, refers to a “Large wooden plant with a trunk that branches at the top to form a crown” (Ferri et al, 2003, p.11).

This paper starts from the hypothesis that the comparison between the cognitive model and tree constitutes a conceptual metaphor, that is, to the conception that “the cognitive model

is structured like a tree”, leading to the transposition of characteristics of the parts of a tree to the cognitive model. Conceptual Metaphor Theory reports that “thought processes are largely metaphorical and the human conceptual system is metaphorically structured and defined” (Lakoff & Johnson, 1980/2002, p. 48). Thus, the metaphors infiltrate thought, guiding actions, perceptions, and concepts, interfering in how individuals behave facing their domains. So, it’s important to clarify the transposed characteristics between the tree and cognitive model domains, verifying their similarities and differences, since these characteristics can interfere in the perception about the cognitive model.

Therefore, integrating three distinct areas of knowledge, that is, (1) Analogies, Metaphors, Models, (2) Psychology - Cognitive-Behavioral Theory, (3) Biology - Botany, highlighting the importance of A&Ms in language, thought, and cognition, this research aims to contribute to studies in Psychology through the systematic and methodological analysis of the comparison between tree and cognitive model of the Cognitive-Behavioral Theory, establishing similarities and differences between the comparative domains.

Analogies, Metaphors, and Models

Frequent and popular, analogical thinking originates from the emergence of language, helping to understand the new, and construct senses and meanings. When related to comparisons, A&Ms are distinguished. The first theories on metaphors are from Aristotle (384 BC - 322 BC). De Lima (2005, p. 10) indicates that Aristotle defines metaphor as “to carry to one thing the name of another, or from genus to species, or from species to genus, or from the species of one to the species of another, or by analogy”. Metaphors would constitute a creative act, allowing men to build knowledge by establishing them. Abbagnano (2007) refers to the Aristotelian definition of metaphor.

Regarding the concept of analogy, Abbagnano (2007, p. 55), in addition to quoting Aristotle, refers to Plato, presenting yet a second meaning: “probable extension of knowledge through the use of generic similarities that can be deduced between different situations”. De Almeida (2020) states that confusion about the meaning of analogy is recurrent. For Malheiro and Teixeira (2020, p. 319), analogy does not point to symmetrical equality, but “an assimilation with the intention of elucidating, structuring, and judging the subject through the forum”. Duit (1991) and Treagust et al. (1992) relate analogies to comparisons of similarities between a familiar and an unfamiliar domain. Duit (1991) points out their explicit nature. The A&Ms are essential thinking tools in cognition.

In this work, A&Ms are treated as cognitive, reasoning processes, comparisons of similarities between two domains, one known and one unknown: analogy compares explicitly while metaphor implicitly. An important tool, analogical reasoning is used by scientists to construct knowledge, with analogies being responsible for inferences that generate problem solutions. Yet, the spontaneous use of analogies hardly leads to reflection (De Almeida & Da Silva Diniz, 2021), making it “necessary to delimit which components of a concept are mapped into another” (Siman & Sampaio, 2021, p. 204).

As for metaphors, their understanding and explanation are complex activities (Couceiro Figueira, 2021). However, they’re transformed into analogy when the comparative aspects between the domains are clarified, facilitating their understanding. Nevertheless, transposition is not enough, being important their systematic and methodological treatment, which reduces attributing unwanted aspects to the comparison.

In 1980, Lakoff and Johnson first published the book *Metaphors We Live By*, which was translated into Portuguese only in 2002. There, the authors presented the “Conceptual Metaphor

Theory”, in which the understanding of an idea or domain can be done in function of another domain. For the authors, metaphors carry conceptions and influence thinking and reasoning, and everyday language is full of metaphorical conceptions that we do not always realize. An example would be the metaphor “time is money”. By establishing this conceptual metaphor, the domain “time” is now conceived as the domain “money”, influencing thoughts and actions. Thus, expressions and behaviors are established, such as: “saving” time, “spending” time, “gaining” time, “losing” time, etc. Lakoff and Johnson (1980/2002) did not establish relationships between the arguments of everyday life and those of scientific life, but Marcelos and Nagem (2010) recognize the presence of conceptual metaphors in science and its discourse. Furthermore, they point out that Lakoff and Johnson (1980/2002) indicated that so-called pure intellectual concepts, such as the concepts of a theory, for example, are often - perhaps always - based on metaphors.

Physical or virtual representations (drawings, models, animations, etc.) that show comparative relationships are classified by Nagem et al. (2022) as models. In this way, the authors corroborate Oliva (2019), for whom analogies are resources employed in model making and state, “models are analogical representations in constant motion” (Nagem et al., 2022, p. 71). Therefore, by partially representing entities of scientific interest, models can be called analogical, establishing relations of similarity between domains in which differences can also be relevant.

Marcelos and Nagem (2011) classify analogies as: structural - compares the morphology of the domains; functional - compares functions of the domains; zoomorphic - characteristics of living beings are granted to phenomena; frozen - used for a long time, consolidated, does not surprise the listener. It is to be assumed that zoomorphic analogies comprise only those involving animals. Thus, in this paper we use the term phytomorphic for plant analogies.

Vehicle-Target Comparative Structure Models

The comparison between the cognitive model and tree evokes the analogy between the Darwinian Theory of Evolution of living beings and a tree. This analogy was analyzed by Marcelos and Nagem (2010), generating eleven comparative charts containing structural and functional similarities and differences between the domains. In 2020, Santos resumed aspects of the analogy between a tree and the Darwinian Theory of Evolution of living things without extending the charts (Santos, 2020).

The charts were named by Marcelos and Nagem (2010) as “Comparative Structure Models of Similarities and Differences Between Vehicle and Target”. The term vehicle refers to the known domain of the analogy, i.e., the Tree, and the term target refers to the domain one wishes to understand, in this case, the Darwinian Theory of Evolution of living things. It is worth noting that there is a wide variety of terms available to describe the domains. The choice of the target term is due to its almost consensual character, while the choice of the vehicle term occurs because it refers to the idea of movement, which, according to Nagem et al. (2001), facilitates the understanding of the role of analogy in leading to the understanding of the target. The richness of the relationships established identified conceptual metaphors and evidenced the potential of the comparative structure.

The origin of the Comparative Structure Models of Similarities and Differences between Vehicle and Target lies in Education research, specifically in the *Metodologia de Ensino Com Analogias* (MECA, Methodology for Teaching With Analogies), developed by Nagem et al. (2001). One of the five steps of MECA is the construction of comparative charts in which similarities and differences are established between the vehicles and targets of the analogy being studied. Focus is directed at

the similarities, as these characterize the analogy, but it is important to list the relevant differences to prevent the reader from attributing undesirable and irrelevant characteristics of the vehicle to the target.

When the charts were given the status of models in the work of Marcelos and Nagem (2010), they pointed out the possibility of using the same structure to analyze comparisons between domains in any area of knowledge and context, including Psychology. It is, therefore, a strategy for systematized and methodological analysis of analogies that can be used to analyze the relations of similarity and difference between a tree and the cognitive model of CBT.

Ferry and Paula (2017, p. 30) present a mapping of the structure of analogies, which originates from Cognitive Psychology and is employed in Education research for the “understanding of the use of comparisons in the teaching and learning processes of scientific subjects”. The following year, Ferry et al. (2018), without refuting MECA, discussed the role of differences in analogies, highlighting that, like similarities, they can also provide gains in concept assimilation. Barbosa and Ferry (2018) developed a software to facilitate the reading of the processes of analysis of structural characteristics of comparisons – the *Sistema Para Mapeamento Estrutural de Analogias* (MAPES, System for Structural Mapping of Analogies). In this way, it is feasible to analyze and highlight the complexity of the structure of similar relations placed in correspondence in an analogy, such as those that make up the Comparative Structure Models of Similarities and Differences between Vehicle and Target.

In addition to the works mentioned, the comparative similarity and difference charts, before or after acquiring the status of models, have been employed and corroborated in other research on teaching. However, no references to the development of these types of charts were found outside the educational context, including in the field of Psychology.

Cognitive-Behavioral Theory (CBT) and the Cognitive Model

Authored by Aaron T. Beck in the 1960s, CBT emerged premising problem solving in a cooperative therapist/patient alliance, distinguishing itself by being of empirical inquiry and reality testing. Beck (2019), Aaron Beck’s daughter, clarifies that cognitive-behavioral psychotherapy was designed for the treatment of depression, associated with distorted thoughts and beliefs. In his works, Aaron Beck noted the cognitive conceptualization of depression related to a negative way of thinking of patients.

Simple, directive, and pragmatic, CBT is “structured, short-term, present-oriented, directed toward current problem solving, modification of dysfunctional (inappropriate and or unhelpful) thoughts and behaviors” (Beck, 2019, p. 22). It relies on the cognitive model, with “a person’s emotions, behaviors, and physiology being influenced by their perceptions of events” (Beck, 2019, p. 50). Behaviors and emotions relate to cognitions (thoughts), determining perceptions of ourselves, others, and the world.

In formulating the cognitive-behavioral model of a patient, it is possible to observe the reported EVENT, the COGNITIVE ASSESSMENT where the personal interpretation is triggered by the activation of beliefs, the EMOTION felt from the perception, generating the BEHAVIOR, which is coherent to the cognitive assessment. From the cognitive assessment, thoughts arise, which are divided into three levels: Core/Central Beliefs (CBs), Intermediate Beliefs (IBs), and Automatic Thoughts (Ats), composing a belief system that leads to the cognitive assessment.

The CBs form the deepest level of cognition, consisting of beliefs about oneself, the world, and other people. Developed mainly during childhood, they depend on the subject’s experiences.

Global, rigid, inflexible, overgeneralized, they influence the emergence of intermediate beliefs. The IBs are rules and statements created by the individual as attempts to make life more “functional”, within the way he sees himself, his environment, and his future. They are attempts to deal with the CBs. The ATs are the first that come before a fact. Common to all of us, they are not random, bearing content from our life history.

The primary goal of CBT is to produce changes in patients’ thoughts and meaning (beliefs) systems, evoking lasting emotional and behavioral transformation. Based on a continuously developing formulation of the patient and their problems in cognitive terms, CBT requires a secure therapeutic alliance, defined by Ramos et al. (2021) as collaboration between therapist and client, and emphasizes active patient collaboration and participation. The cognitive-behavioral model, assisting in the identification of problems reported by patients, shifts the focus away from events and places it on how the patient interprets them, allowing perception of dysfunctional thoughts. Once such thoughts are perceived, there is the need to modify them, seeking to install realistic adaptive mental patterns that lead to positive changes in the emotional state that will reflect in behavioral changes. It should be emphasized that dysfunctional thoughts underlie all psychological disorders.

Therefore, a patient’s cognitive assessment, that is, their beliefs and behavioral developments, should be the target of attention of therapists who, by understanding it, will be able to aim for cognitive change that will impact their feelings and behavior. By elaborating Comparative Structure Models between the tree Vehicle and the cognitive model Target, it establishes the possibility, through the analysis of similarities and differences, of contributions to the comprehension of the characteristics of the cognitive model’s levels of thinking. By extension, it is to be assumed that it may aid in the understanding of the patient’s cognitive assessment, an assumption that is subject to further verification, being that it isn’t the object of this work.

Method

This research is qualitative, exploratory in nature, with documentary analysis, grounded in the theoretical framework on A&Ms and in Beck (2019).

Instruments

Two interrelated instruments were used. The first (mental) is analogical reasoning as a tool to build new knowledge by identifying and establishing relationships of similarities and differences between distinct domains. The second instrument (physical) are comparative charts based on the Comparative Structure Models of Similarities and Differences between Vehicle and Target (Marcelos & Nagem, 2010), which, in turn, come from the MECA (Nagem et al., 2001). The charts are composed of columns of similarities and differences between the domains of an analogy to be filled in using analogical reasoning.

Procedures

Research in texts and on the internet, verifying the authorship of the comparison, representations, and descriptions. The sources of Information were the platforms Research Gate, Google Scholar, and Indexpsi, Psychology professionals’ webpages, social networks, and YouTube channels, using combinations of the descriptors: analogy, beliefs, metaphor, cognitive model, automatic thoughts, CBT, and the terms related to Botany, such as tree, leaves (organ that grows on

the stem, with limited growth, is usually green, and has photosynthesis as its main function), root (organ of attachment of the plant to the soil from which it withdraws water and nutrients), trunk (strong and massive stem of trees and large shrubs). The part between the root and the leaves is called “stem”.

Identification of vehicle and target domains and classification of comparison and representations according to Duit (1991), Lakoff and Johnson (1980/2002), Nagem et al. (2022), and Oliva (2019).

Elaboration, through analogical reasoning, of a general comparative tables of similarities and differences between the vehicle (tree) and the target (cognitive model) based on Marcelos and Nagem (2010).

Elaboration of a proposed analogical model for comparison, expressed through illustration, containing the vehicle (tree), the target (cognitive model), pointing out the correspondence between the root and Central/Core Beliefs; trunk and Intermediate Beliefs; leaves and Automatic Thoughts.

Following the elaboration of the general tables mentioned in item 3 and the proposal of the analogical model mentioned in item 4, through analogical reasoning, three new comparison charts were established between: root and Central/Core Beliefs; trunk and Intermediate Beliefs; leaves and Automatic Thoughts. Analysis of the tables constructed in 3 and 5.

Despite the wide range of plants’ variety of roots, stems, and leaves, only characteristics of the typical forms found in trees were observed in the elaboration of the charts. The aspects listed are due to the botanical knowledge of the authors, supported by literature on plant morphology – organography.

Since this research does not involve subjects, it does not fit into the ethical precepts of specific resolutions and laws for research with humans and animals. However, ethical aspects were observed, such as respect for intellectual property and credit to other authors.

Results and Discussion

Within the research, we did not find a description of the comparison between tree and cognitive model, nor even mention of it in academic texts. We found references to it in animations of videos on YouTube and illustrations on webpages and social networks of clinics and cognitive behavioral psychologists. Some pages suggest that the author is the American psychologist Robert L. Leahy, director of the American Institute for Cognitive Therapy and clinical professor of Psychology in the Department of Psychiatry at Weill Cornell Medical College, both in New York, but we found no confirmation of this information in our research or even an answer to an email sent to the above-mentioned researcher.

Most of the representations bring few explanations, suggesting that psychologists conceive that they favor the understanding of the cognitive model, but without realizing the possibilities of relations between the domains, nor of their systematic exploration. A single video featured a more elaborate animation, depicting relationships between a tree and the cognitive model, emphasizing the similarities but not reporting the differences and not establishing many possible relationships. We consider this type of representation as an analogical model, according to notes by Nagem et al. (2022) and Oliva (2019).

The comparison is sometimes referred to as an analogy, sometimes as a metaphor, evidencing a recurring difficulty of distinction. Initially, the mention of a tree that symbolizes cognitive functioning makes one think that the cognitive model is structured and functions like a big tree. We consider that we are facing a conceptual metaphor (Lakoff & Johnson, 1980/2002), with the tree as the vehicle and the cognitive model as the target. The description of the established similarities makes the metaphor explicit, transforming it into an analogy according to Duit's (1991) concepts. Therefore, we classify: (1) the schematic, illustrative representations of the tree/cognitive model relationship as analogical models; (2) the conception that the cognitive model is structured like a tree as conceptual metaphor; (3) the comparison between tree and cognitive model without describing the established relationships as metaphor; (4) the comparison between tree and cognitive model in which aspects are described, even in limited detail, as analogies. Table 1, below, lists similarities and differences between the domains of the tree/cognitive model analogy of CBT.

Table 1

Comparative Structure Model of Similarities and Differences between the vehicle Tree and the target Cognitive Model of Cognitive-Behavioral Theory

Similarities		Differences	
Vehicle	Target	Vehicle	Target
Tree	CBT Cognitive Model Core/Central Beliefs (CBs)	Tree	CBT Cognitive Model Core/Central Beliefs (CBs)
	↓ Intermediate Beliefs (IBs)		↓ Intermediate Beliefs (IBs)
	↓ Automatic Thoughts (ATs)		↓ Automatic Thoughts (ATs)
It's a tree	It's a tree	Literal tree	Metaphorical tree
Complex system	Complex system	Physically exists	Doesn't physically exist
Supports the structure, but with constant modifications	Supports the structure, but with constant modifications	Changes in morphology, physiology, biochemistry	Changes in beliefs and thoughts
Three basic parts	Three basic parts	Root, trunk, leaves	CBs, IBs, ATs
The root is the base; trunk, the intermediate part; leaves, the top part	The CBs are the base, IBs are the middle, ATs are the top	The tree has a branched root, a single branched trunk, and many leaves	The cognitive model can have several CBs, several IBs, and several ATs
Some leaves are close together; others, with a common trunk, are far apart.	There are thoughts close together; others, with common IBs, far apart	The leaves are directly connected to the trunk of the tree (intermediate part)	The ATs are directly connected to the CBs, (deepest level)
It requires a few factors for its survival	It requires a few factors for its existence	Needs: light, water, soil	Needs: situation, cognitive assessment, emotion, behavior
The tree develops throughout its existence	The cognitive model develops throughout its existence	The development increases the branching of the root, branches, leaves, thickens the root, trunk, branches	Development increases CBs, IBs, and ATs, making them stronger or weaker based on functionality or dysfunctionality
A branch falls, takes the leaves that are attached	A IB is deconstructed, takes away attached ATs		

Note: CBT: Cognitive Behavioral Theory.

Note on Table 1: Branches are subdivisions of the stem, also called tree ramifications. In the table there's a representation of the cognitive model contained in Beck (2019). Automatic thoughts are located at the bottom, intermediate beliefs in the middle, and core or central beliefs at the apex, related by descending arrows. By analyzing it using analogical reasoning, we glimpse the possibility of a new representation to better represent the correspondence between vehicles and targets in

the analogy between cognitive model and tree: by inverting the position of the levels of thoughts, as well as the direction of the arrows. In this case, the core or central beliefs would then occupy the bottom of the representation and the automatic thoughts the top, making the location of the targets in the cognitive model compatible with the location of the vehicles in the tree.

We classify the analogy between tree and cognitive model as phytomorphic, since it confers the target characteristics of a plant that is the vehicle. Similarities and differences indicate that the analogy has a functional and structural character, since the cognitive model structures and functions similarly to a tree.

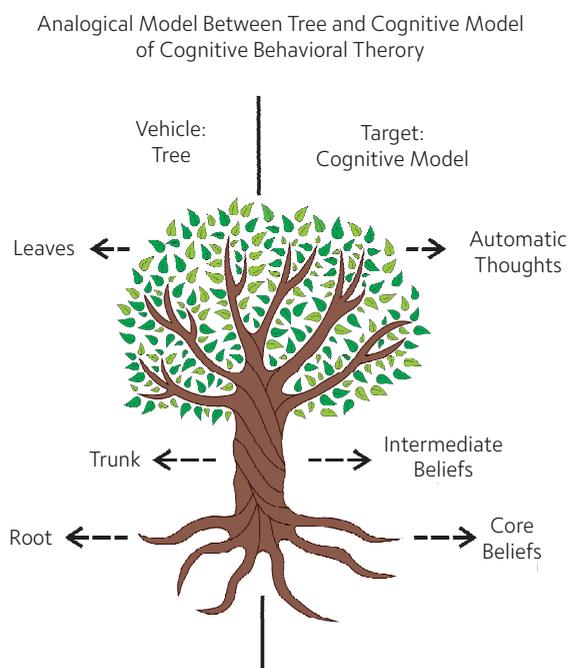
Concerning “when an intermediate belief is deconstructed, it takes away all the automatic thoughts linked to it”, we point out that, although it is pertinent, it does not seem simple to perform such a deconstruction, because the interventionist processes in CBT focus on the deconstruction of CBs and ATs in detriment of IBs, suggesting to us that this is a more difficult process.

The similarities and differences established refer to the existence of conceptual metaphors (Lakoff & Johnson, 1980/2002), that is, one situation taken for another. We highlight: core or central belief is the root; intermediate belief is the trunk; leaves are automatic thoughts, because each of these parts of the cognitive model is conceived as these respective parts of a tree. Generally, these are the metaphors that Psychology professionals establish and seek to explain by relating targets and vehicles. The lack of systematization can lead to misconceptions about the target.

By conceptualizing beliefs and thoughts in this way, illustrations compatible with analogical models emerge. The ones we found focus on the target, using the vehicle as a mere instrument, rather than treating the relationship as an analogy. In this form, they do not clarify who is target and vehicle. We present, in Figure1 below, our proposed analogical model between tree and cognitive model of CBT.

Figure 1

Analogical Model Between Tree and Cognitive Model of Cognitive Behavioral Theory



Each vehicle and target in Figure 1 elicit similarities and differences models. Table 2, below, shows the similarities and differences between the vehicle Root and the target Core Beliefs of the CBT cognitive model.

Table 2

Comparative Structure Model of Similarities and Differences between the vehicle Tree and the target Core/Central Beliefs of the Cognitive Model of Cognitive-Behavioral Theory

Similarities		Differences	
Vehicle	Target	Vehicle	Target
Root	Core/Central Beliefs (CBs)	Root	Core/Central Beliefs (CBs)
			
It's the base of the tree	Are the base of the cognitive model	Branched, cylindrical, achlorophyllous structure	Lasting, fundamental, profound concepts
Fixation and support	Fixation and support	Anchors the tree to the ground and upholds it	Supports the structure of the cognitive model
Nutrition	Nutrition	Nourishes the tree trunk and crown	Nourishes IBs and ATs
Rigid	Rigid	Tissue rigidity due to the presence of substances such as lignin	Rigidity in ideas, due to life history, education, trauma, relationship with environment/culture/values, neurobiological vulnerability
Different types	Different types	Underground, aerial	Lovelessness, helplessness, worthlessness
The underground root remains covered	CBs remain covered	Covered up by the soil	Covered up by behaviors
The underground root is not visible	The CBs, at first, are not visible.	A person knows it exists	The person does not know that their CBs exist
The underground root is difficult to access	CBs are difficult to access	Accessible by excavation	Accessible through psychotherapy
The underground root runs deep	CBs run deep	Underground roots run deep, aerial don't	All CBs run deep
They originate early, at the start of plant formation, and get stronger in life	They originate early, at early development, and get stronger in life	It originates from the radicle	They originate from the way a person seeks to understand the environment
		A tree has a single taproot	A person can have several different independent CBs

Note on Table 2: Lignin is the substance that promotes the consistency of wood. Subterranean roots are those that lie below ground. Aerial roots develop above ground, being visible in the stem or leaves. Radicle is the part of the embryo in the seed that gives rise to the root. The main root is called the taproot, a single root, from which small roots branch out – the lateral or secondary roots.

We consider that the analogy between root and CBs is structural and functional, that is, the CBs are structured and function like the root of a tree. In this way, the CBs, like the roots, appear as the base of the belief system, which structures and sustains it, being strong, deep, rigid, and of difficult access. By establishing such relationships, these metaphorical conceptions are intensified, and therefore the way therapists can perceive them.

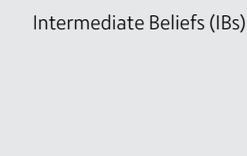
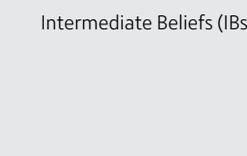
It is noteworthy the fact that although there's a single root, it branches out while there are several CBs in the cognitive model. Thus, to impact the whole tree (plant), it is enough to strike its taproot. However, a CB can exist independent of another CB, and the removal of one does not

cause the removal of the other, impacting only part of the tree. For us, an image, although absurd, implausible, would appear more adequate: that of a “tree” formed by several branched taproots, each of them being a CB.

We found no references on the soil that covers the core or central beliefs. We suggest that it is formed by the behaviors, because these are visible, accessible, on the surface, while the CBs are “behind” them, “hidden”. Some representations place the behaviors at the leaf level, but we think that they are more sedimented, like the soil, and therefore this is a more assertive relationship. It is worth pointing out that the establishment of beliefs occurs since childhood, in the process of socialization, and these beliefs are reinforced throughout life, developed in the cognitive process, establishing behaviors. In the therapeutic process, CBT analyzes the behaviors and exposes the beliefs, showing the root. Following the analogy analysis, Table 3, below, exposes the model of some similarities and differences between the vehicle Trunk and the target Intermediate Beliefs of the Cognitive Model of the Cognitive-Behavioral Theory.

Table 3

Comparative Structure Model of Similarities and Differences between the vehicle Trunk and the target Intermediate Beliefs of the Cognitive Model of Cognitive-Behavioral Theory

Similarities		Differences	
Vehicle	Target	Vehicle	Target
Trunk	Intermediate Beliefs (IBs)	Trunk	Intermediate Beliefs (IBs)
			
Intermediate part of the tree	Intermediate part of the cognitive model	It is the stem of the trees	Rules, attitudes, and assumptions as truths
Connects underground root to leaves	Connects Core/Central beliefs (CBs) to Automatic Thoughts (ATs)	A tree has a single trunk	In a person's cognitive model, many IBs can coexist
Each trunk connects to a single root	Each IB connects to a single CB	The trunk ramifies to form branches	IBs do not unfold into other IBs
Located at the ground surface, are easy to access	They are at the surface of the behaviors, are easy to access	Despite easy access, it's rigid	Can be rigid or not
Support	Support	Physical support	Gives meaning to CBs
Connected to the root	Connected to the CBs	It ceases to exist when cut, but the root remains	It only ceases to exist when the CB to which it is attached is extinguished
Conduction	Conduction	It conducts sap to the leaves and root	It conducts the CB values to the ATs
Originate early	Originate early	It originates from the seed at the beginning of plant formation	Originates from CBs, at early development
Develop throughout life	Develop throughout life	Is more developed at the base than at the apex	Same structure throughout its length.
Gives rise to other structures	Gives rise to other structures	Buds give rise to branches and leaves	It originates adaptation to CBs and makes them more functional.
Essential for plan growth	Essential for model growth	Source of hormones that develop the plant	Source of rules that develop ATs

Note on Table 3: sap is the nutrient solution carried inside the plants. Buds are protuberances of the stem that originate leaves, flowers, and branches.

In Table 3 there are relations of structure and function between the domains of the analogy, which classifies it as structural and functional. It is important to highlight that the tree has only one

trunk with many branches, while there are many IBs, which could suggest that the branches are related to the various IBs of a person. However, we do not consider this to be the most adequate analogical relation, since the branches are bifurcations of the same trunk, that is, it would be like an IB originating all the other IBs. We deem more adequate a hypothetical tree formed by several trunks where each one would be an IB, but this image would be unreal.

Regarding the analogy established to clarify the target AT, some representations found on the Internet point to different vehicles, such as tree branches, fruits, and leaves. However, the branches are part of the trunk that is equivalent to the IBs and not to the ATs. Fruits (and also flowers) are seasonal, and automatic thoughts are always present in the cognitive model. Therefore, we consider leaves to be a more appropriate vehicle and have chosen it below in Table 4.

Table 4

Comparative Structure Model of Similarities and Differences between the vehicle Leaves and the Target Automatic Thoughts of the Cognitive Model of Cognitive-Behavioral Theory

Similarities		Differences	
Vehicle	Target	Vehicle	Target
Leaves	Automatic Thoughts (ATs)	Leaves	Automatic Thoughts (ATs)
			
Top of the tree	Top of the cognitive model	Photosynthesizing organ, stem expansion	Quick, evaluative thoughts
Numerous	Numerous	They arise from the apical or cauline meristem from the embryo germ	They arise spontaneously in situations from the CBs
Located at the ground surface	They are at the surface of the behaviors	Difficult to access due to the size of the tree	Are easy to access
Connected to the trunk	Connected to the IBs	Leaves from the same tree look alike	Different ATs can coexist in a situation
Present in every tree	Present in everyone's cognitive model	Except in the case of deciduous plants they are constant throughout the life of a tree	They occur when thinking of the past, experiencing the present, and when imagining the future
Produce something	Produce something	They produce glucose through photosynthesis	They produce positive or negative emotions through their interpretations
		Fixed on the branch	Uncontrollable, in the form of flashes
		They always appear in the same shape	They come in the form of phrases or images

Note on Table 4: meristem is undifferentiated tissue that gives rise to other tissues. Deciduous are plants that lose their leaves. Gemma is a bud that originates stem and leaves.

In the relationship between the leaf and ATs domains, we find structural and functional aspects. Due to the quick, flash nature of the ATs, this is the most complex analogical relationship of those between the domains of a tree and the cognitive model, difficult to analyze, corroborating Couceiro Figueira (2021) about the difficulty in dealing with metaphors and, we add, analogies. The number of differences is shown to be greater than the number of similarities, but it is worth noting that these differences are relevant and contribute to the understanding of the target.

Conclusion

The results of the research corroborate the hypothesis that gave rise to this research: the comparison between cognitive model and tree constitutes a conceptual metaphor, that is, the conception that “the cognitive model is structured like a tree,” leading to the transposition of characteristics of the parts of a tree to the cognitive model. The elaboration of the tables shows us that there are more similarities and differences between the domains than what was found in materials on the Internet. We considered that, while several of the relationships we established would be possible to be elaborated by Psychology professionals with an attentive eye, others would require a greater biological knowledge about the characteristics of trees, going beyond psychologists’ field of knowledge. However, this fact does not invalidate the exercise of establishing relationships between vehicles and targets, of seeking to understand them and employ them to understand the cognitive model.

Regarding the domains, we emphasize that an analogy does not point to symmetrical equality. Target and vehicle are not identical, and if they were, they would constitute the same object, not distinct objects. Thus, differences do not invalidate analogy.

As stated earlier, the fact that the root is single and branched while the CBs are many, and the same occurs in the trunk/IBs relationship, can give rise to surreal tree analogical models. We therefore suggest that it is more appropriate to think of the cognitive model not as a single tree, but as a forest. In each tree, the root would correspond to a single CB and the trunk to a single IB.

We emphasize that the charts are not finished works, but under construction. The presence of blank spaces and lines to be filled in reveals the possibility of establishing other similarities and differences according to the cognitive or experiential potential of the individuals, enriching the analysis.

Likewise, other comparative charts can be established using possible relations between the cognitive model and other parts of a tree that were not explored in this manuscript, such as: flowers, fruits, seeds, etc.

We emphasize that by analyzing the analogy and building the charts, both aspects of the target and the vehicle are clarified. In this way, the use of Comparative Structure Models enhances the understanding of the whole analogy, going beyond its initial goal of making the target more understandable.

Finally, as future considerations, our next step will be to use the MAPES system to map the established relationships, aiming to analyze and highlight their complexity. Later, we will verify how cognitive-behavioral clinical psychologists evaluate the established relations and we will seek to examine if they can impact the therapeutic perception of the cognitive evaluation of patients. We foresee that, in this way, possibilities for the elaboration of materials may be opened, be they analogical models, videos, or texts that may present greater relations between these vehicles and targets, helping in the understanding of the characteristics of the levels of thought of the cognitive model.

References

- Abbagnano, N. (2007). *Dicionário de Filosofia* (5th ed). Ed. Martins Fontes.
- Barbosa, W. V., & Ferry, A. S. (2018). Concepção de um software para mapeamento estrutural de analogias empregadas no ensino de ciências. *Revista de Estudos e Pesquisas sobre Ensino Tecnológico-EDUCITEC*, 4(08), 224-243. <https://doi.org/10.31417/educitec.v4i08.580>

- Beck, J. S. (2019). *Terapia cognitivo-comportamental: teoria e prática* (2nd ed.). Artmed.
- Couceiro Figueira, A. P. (2021). Comprensión del lenguaje figurado. Evaluar e intervenir: dos recursos. *International Journal of Developmental and Educational Psychology*, 1(2), 315-318. <https://doi.org/10.17060/ijodaep.2021.n2.v1.2186>
- De Almeida, H. A. (2020). As concepções sobre analogias no discurso de licenciandos em ciências biológicas. *Enseñanza y Aprendizaje de las Ciencias*, 15(1), 101-117. <http://doi.org/10.14483/23464712.14401>
- De Almeida, H. A., & Silva Diniz, R. E. (2021). Intersecções entre o movimento de formação docente reflexivo e a estratégia de ensino com analogias Guia FAR. *Tecné, Episteme y Didaxis*, 2920-2927. <https://revistas.pedagogica.edu.co/index.php/TED/article/view/15211>
- De Lima, A. (2005). A metáfora: da analogia à técnica de fusão de opostos. *Revista Investigações – Linguística e Teoria da Literatura*, 18(1), 9-40.
- Duit, R. (1991). On the Role of Analogies and Metaphors in Learning Science. *Science Education*, 75(6), 649-672. <https://doi.org/10.1002/sce.3730750606>
- Ferri, M. G., Menezes, N. L., & Monteiro, W. R. (2003). *Glossário Ilustrado de Botânica*. Ed. Nobel.
- Ferry, A. S., & Paula H. F. (2017). Mapeamento estrutural de analogias enunciadas em uma aula sobre cinética química. *Ciência & Educação*, 23(1), 29-50. <https://doi.org/10.1590/1516-731320170010003>
- Ferry, A. S., Vieira, M. L. A., & Nagem, R. L. (2018). análise estrutural de uma contra-analogia construída em uma sala da aula de Química. *Latin American Journal of Science Education*, 5, e22002.
- Lakoff, G., & Johnson, M. (2002). *Metáforas da vida cotidiana* (M. S. Zanotto, Trans.). Mercado das Letras. (Original published 1980)
- Malheiro, J. M. S., & Teixeira, O. P. B. (2020, abril). Processo comunicativo em um curso de formação de professores: uma análise baseada nos princípios argumentativos de Perelman e Olbrechts-Tyteca. *Investigação em Ensino de Ciências*, 25(1), 306-328. <https://doi.org/10.22600/15188795.ienci2020v25n1p306>
- Marcelos, M. F. & Nagem, R. L. (2010). Comparative structural models of similarities and differences between vehicle and target in order to teach darwinian evolution. *Science & Education*, 19(6-8), 599-623. <https://doi.org/10.1007/s11191-009-9218-2>
- Marcelos, M. F., & Nagem, R. L. (2011). Use of the "Tree" Analogy in Evolution Teaching by Biology Teachers. *Science & Education*, 21, 507-541. <https://doi.org/10.1007/s11191-011-9370-3>.
- Mathieson, F., Jordan, J., & Stubbe, M. (2020). Recent applications of metaphor research in cognitive behaviour therapy. *Metaphor and the Social World*, 10(2), 199-213. <https://doi.org/10.1075/msw.00003.mat>
- Moser, K. S. (2000). Análise de metáforas em psicologia - método, teoria e campos de aplicação. *Forum: Qualitative Social Research*, 1(2), e1090. <https://doi.org/10.17169/fqs-1.2.1090>.
- Nagem, R. L., Araújo, S. P., & Marcelos, M. F. (2022). A&M 20 anos: formação e atuação de pesquisadores em analogias, metáforas e modelos. Ed. Fi. <https://doi.org/10.22350/9786559173730>
- Nagem, R. L., Carvalhaes, D., & Dias, J. A. (2001). Uma proposta de metodologia de ensino com analogias. *Revista Portuguesa de Educação*, 14(1), 197-213.
- Oliva, J. M. (2019). Distintas acepciones para la idea de modelización en la enseñanza de las ciencias. *Enseñanza de las Ciencias*, 37(2), 5-24. <https://doi.org/10.5565/rev/ensciencias.2648>
- Ramos, A. R. S., Souza, A. C. A., Brito, R. C. L., & Gomes, U. S. (2021). Aliança Terapêutica na Terapia Cognitivo Comportamental: uma análise cienciométrica. *Psicologia em Ênfase*, 2(2), 108-122.
- Reyes, A. N., & Fermann, I. L. (2017). Eficácia da Terapia Cognitivo-Comportamental no Transtorno de Ansiedade Generalizada. *Revista Brasileira de Terapias Cognitivas*, 13(1), 49-54. <http://dx.doi.org/10.5935/1808-5687.20170008>
- Santos, S. C. S. (2020). Uma reflexão sobre o uso de analogias no ensino de ciências e o desdobramento multimodal da realidade: o exemplo de tópicos da teoria da evolução biológica. *Investigações em Ensino de Ciências*, 25(2), 80-97. <http://dx.doi.org/10.22600/1518-8795.ienci2020v25n2p80>
- Siman, J. H., & Sampaio, T. O. M. (2021). Teoria da metáfora conceptual. *Porto das Letras*, 7(1), 201-220.

- Soares, A. B., Lima, C. A., Rodrigues, I. S., Santos, G. G. B., Sousa, B. A., & Mendes, V. S. A. (2020). Terapia Cognitivo Comportamental: o que pensam os estudantes de Psicologia? *Revista Brasileira de Terapias Cognitivas*, 16(2), 99-106. <https://dx.doi.org/10.5935/1808-5687.20200015>
- Treagust, D., Duit, R., Joslin, P., & Lindauer, I. (1992). Science teachers' use of analogies: observations from classroom practice. *International Journal of Science Education*, 14(4), 413-422. <https://doi.org/10.1080/0950069920140404>

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M. F. MARCELOS contributed to the conception of the work; research and writing of all the sections of the article; analysis, interpretation, and discussion of the results; revision according to APA and journal norms, approval of the final version. R. L. NAGEM contributed to the writing and revision on A&Ms; elaboration and revision of the charts; analysis, interpretation, and discussion of the results, approval of the final version. A. R. ANDRADE contributed to writing and revision on CBT; elaboration and revision of the charts; analysis, interpretation, and discussion of the results, final approval.