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Assessing metaphor comprehension in Alzheimer's patients

Djenoune OUAHIBA
University Mohamed LamineDebaghine-Setif 2-
URDRH
Ouahiba_djenoune@yahoo.fr
https://orcid.org/0009-0009-8629-4137

Iatidel AGUIDA
University Mohamed Lamine Debaghine-Setif 2-
URDRH
aguidananou@gmail.com
https://orcid.org/0009-0006-3766-4953

Abstract:
The present study aims to assess the level of metaphor comprehension in Alzheimer's patients. We adopted a comparative methodology. The study sample consisted of 11 individuals with Alzheimer's disease (AD) and 15 healthy control subjects. We administered the Mini-Mental State Examination (MMSE), and participants were asked to provide the meaning of 20 metaphorical expressions. We found statistically significant differences between the AD patients and the control group in their level of metaphor comprehension.

Keywords: *Metaphor; Alzheimer's disease; Pragmatics.*

Évaluation de la compréhension des métaphores chez les patients atteints de la maladie d'Alzheimer

Résumé :
La présente étude vise à évaluer le niveau de compréhension des métaphores chez les patients atteints de la maladie d'Alzheimer. Nous avons adopté une méthodologie comparative. L'échantillon de l'étude était composé de 11 personnes atteintes de la maladie d'Alzheimer (MA) et de 15 sujets témoins en bonne santé. Nous avons administré le Mini-Mental State Examination (MMSE) et demandé aux participants de donner la signification de 20 expressions métaphoriques. Nous avons constaté des différences statistiquement significatives entre les patients atteints de MA et le groupe témoin en ce qui concerne leur niveau de compréhension des métaphores.

Mots clés *: Métaphore ; Maladie d'Alzheimer ; Pragmatique.*

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Introduction

In their introduction, Evans, Bergen, and Zinken (2007: 2) describe the goal of Cognitive Linguistics as "the study of the links between human language, thought, and social and physical experiences" (as cited in MarianeGingras Harvey, 2014: 4). They divide the discipline into two branches: "cognitive approaches to grammar" and "Cognitive Semantics" (Evans, Bergen etZinken, 2007: 5, as cited in MarianeGingras Harvey, 2014: 4). The latter is concerned with the relationship between cognitive structures and semantic structures (Schwarz, 1995; Brandt, 2005), and one of its most important topics is metaphorology (the study of metaphor).

According to the Larousse dictionary, the word "metaphor" (Latin: *metaphora*, from Greek *metaphora*, *metapherein* "to transfer") signifies the use of a concrete term to denote an abstract concept through analogical substitution, without introducing elements that refer to a simile. According to Lacan, it is a process of substituting one signifier for another, which then becomes implicit (this corresponds to Freud's concept of "condensation" in dreams). The Le Robert dictionary defines metaphor as a linguistic process (a figure or trope) that consists of modifying the meaning (a concrete term in an abstract context) via analogical substitution.

Although metaphor is an ancient topic, with origins tracing back to ancient philosophers like Socrates, where it was seen as a stylistic figure belonging to fields like literature and rhetoric, modern theories—such as

Contemporary Metaphor Theory (CMT)—consider it a cognitive phenomenon. According to CMT pioneers Lakoff and Johnson (*Metaphors We Live By*, 1980), metaphor is one of the foundations of the conceptual system through which we understand and express our experiences of the world. It is fundamentally conceptual, meaning it transcends the purely linguistic level and is rooted in human thought.

These same principles were adopted by Fauconnier and Turner's "Conceptual Blending Theory" (or Conceptual Integration Theory). This theory sought to establish a unified theoretical framework for understanding diverse linguistic phenomena, including metaphor, by linking them to broader cognitive processes. Fauconnier and Turner posit the existence of "mental spaces" responsible for comprehension, such as the specific connections between numerous conceptual domains. Conceptual Blending Theory also allows for the description of how both familiar and complex metaphors are employed (LIAO Xinmei, 2021: 188). Based on linguistic cues (syntactic structures, tense, aspect) and pragmatic factors, Fauconnier studied the processes involved in constructing mental representations, which he termed "'spaces'". The primary feature of these spaces is not to refer to or represent the world, but rather to reflect the speakers' ways of thinking and speaking. This gradual construction of spaces corresponds with information processing by partitioning it into different cognitive domains and "cognitive spaces" (Col, 2010: 2, as cited in LIAO Xinmei, 2021: 189).

Metaphor is also used extensively in our daily lives; it is a fundamental linguistic phenomenon reflecting a close integration between language and cognition. It contributes to constructing meaning, facilitating communication, and

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expressing emotions more effectively. Its frequent use in daily discourse indicates its embeddedness in the cognitive structure of language, owing to its role in fulfilling human communicative and cognitive needs. Consequently, it is essential in the communication process as an important element of inferential reasoning.

This latter element—inferential reasoning, itself a component of pragmatics—is a process that allows for the understanding of the difference between what is literally or explicitly said and its implicit meaning. These pragmatic inferences integrate context and, more broadly, all constituent elements of the interaction, including non-verbal elements that must be processed to understand and interpret utterances. It is, therefore, an analytical process. The processes necessary to invoke this (implicit) meaning have been shown to be subtle and to demand significant and varied cognitive resources. They require the integration of various verbal and non-verbal pieces of information and necessitate the involvement of diverse and complex processing.

Accordingly, inferential reasoning relies on a set of comprehensive cognitive skills. This has led to several hypotheses explaining why inferential reasoning, in all its forms, becomes impaired. Some have emphasized the role of executive functions: planning, strategy generation, initiation, mental flexibility, updating, decision-making, and inhibition in the process of handling inferential reasoning (Sainson et al., 2014). Any impairment at this level leads to a deficit in pragmatic skills (Monettaet Champagne, 2004). Specifically, impairments in mental flexibility and inhibition lead to difficulties in making inferences (George & Wiley, 2016), as

these functions allow one to override the literal meaning of an utterance to provide more coherent interpretations. Others emphasize the importance of Theory of Mind (ToM) in achieving accurate interpretations of inferential processing (Monettaet Champagne, 2004). Furthermore, a relationship has been found between attentional disorders and difficulties in understanding inferential discourse (Penn, 1999). The same applies to memory resources of all types, especially working memory (Estevez etCalvo, 2000, as cited in MagalieBouchoux, 2018: 06).

These cognitive disorders are found to be associated with impaired inferential reasoning in individuals with neurological injuries and diseases (MagalieBouchoux, 2018: 06), including patients with Alzheimer's Disease (AD). AD is a degenerative disease affecting the cerebral cortex, resulting from several physiopathological factors (Sellal et al., 2007). The two characteristic lesions of AD, observed during post-mortem microscopic neuropathological examination, are:

1. **Senile plaques** or "amyloid plaques," which are extracellular deposits of Aß (beta-amyloid) peptide (Backschine et al., 2007, as cited in HYERAN Lee, 2012: 91). According to Thal et al. (2002), these deposits occur sequentially and cumulatively in the neocortex, entorhinal cortex, hippocampus, subcortical nuclei, brainstem, and cerebellum. Therefore, the progression of cognitive decline in AD is hypothesized to follow this sequence (Jack et al., 2009, 2010; Petersen et al., 2009, as cited in Clark et al., in press): Senile plaques form as beta-amyloid accumulates, leading to neuronal dysfunction and cell death; deterioration of neural function; emergence of brain atrophy, which causes changes in brain

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structure; deterioration in cognitive functions, especially memory and executive functions; and the extension of cognitive deficits to other domains, such as language.

2. **Neurofibrillary tangles (NFTs)**, which are aggregates of fibers resulting from the hyperphosphorylation of the Tau protein (Matthieubonhomme, 2004: 1-2). A 2007 collaborative study showed a clear correlation between the progression of neurofibrillary lesions and the emergence of clinical symptoms. Initially, the pathology affects the entorhinal cortex and the hippocampus, which explains the initial precedence of memory deficits. This is followed by pathology in the frontal and cingulate regions, reflecting disorders in language, visuospatial processing, and praxis (voluntary movements). Finally, the primary areas are affected (Backschine et al., 2007; Fouquet et al., 2007).

In general, these two pathologies lead to cell and synapse death, and consequently, to brain atrophy (Schenk et al., 2004, as cited in HYERAN Lee, 2012: 91).

Brain atrophy leads to significant cognitive deficits. In addition to the memory disorders that are the primary manifestation of AD, patients also suffer from other cognitive impairments (LuizaAlves et al., 2012: 1). The diagnosis of AD relies on criteria from the DSM or the (NINCDS-ADRDA). Both classifications emphasize the presence of a deficit in memory and at least one other cognitive domain. The DSM criteria also stipulate that the cognitive disorder must impact social function or activities of daily living (ADLs) (LuizaAlves et al., 2012: 6). As reported by McKhann et al. (2011), AD is diagnosed when

the patient meets the criteria for dementia, in addition to a clear progression of cognitive impairment (by report or observation) and an insidious onset. The initial and most prominent cognitive deficit affects one of the following functions: memory, language, visuospatial function, or executive functions (LuizaAlves et al., 2012: 7).

Thus, it appears that among the deficits experienced by AD patients are communicative and linguistic disorders at all levels; their first symptoms often affect the pragmatic level (Marie Ambroselli, 2012: 4). Language disorders are an integral part of AD symptoms and can even be among the primary, initial symptoms. Different aspects of language are not affected to the same degree, and the deficits are distinct from those in normal aging. The first symptoms are found at the lexical-semantic level, while phonological, morphological, and syntactic processes are preserved in the early stages. Nevertheless, discourse skills are impaired from the very beginning of the disease. Anomia (word-finding difficulty) also appears in the early, mild stages but may be indistinguishable from normal aging, only to become more complex later. Pathological productions emerge: semantic paraphasias and perseverations (of a syllable, word, or topic). Reading words and sentences is not affected until the advanced stages, independent of reading comprehension, which may be impaired. Oral comprehension, however, is often preserved for a long time. In the advanced stages of the disease, the patient may become mute or retain only minimal echolalic or palilalic productions. Writing disorders can also appear in the advanced stages (V. de La Sayette, F. Eustache, B. Desgranges, 2013: 94).

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Therefore, based on the preceding, it is noted that AD patients suffer from varied linguistic disorders that primarily affect the lexical-semantic and discourse levels. These are considered among the most important aspects of pragmatic disorders, as mentioned by Sainson Claire (2018), who outlined pragmatic impairments in: lexical-semantic, inferential, conversational, and discourse aspects.

On the other hand, oral comprehension—which is crucial for inferential understanding (itself an aspect of pragmatic disorder)—is not impaired until the advanced stages of the disease. This leads us to the following research question:

What is the level of metaphor comprehension in patients with moderate-stage Alzheimer's Disease?

Based on the foregoing, **we hypothesize that patients with Alzheimer's Disease suffer from impairments in metaphor comprehension.**

Aims of the Study: The current study aims to assess the level of metaphor comprehension, as an element of inferential reasoning and a crucial communicative aspect ubiquitous in daily life, in patients with moderate-stage Alzheimer's Disease.

1. Definition of Concepts:

Pragmatics: The term 'pragmatics' is often used imprecisely in modern linguistics. It refers to the study of language from the user's perspective, especially the choices they make, the constraints they encounter while using language in social interactions, and the effects their usage has on participants in a communicative act. Difficulties arise in attempting to clarify concepts such as choices, constraints, and effects precisely. It is not easy to compile a

comprehensive list of all factors that must be considered to understand the social intent behind an utterance. For example, if someone says, "I feel cold," it might literally express their feeling of being cold, be a phrase to continue the conversation, an implicit request for a coat from someone else, a suggestion to close a window, and so on.

Thus, whatever the intended meaning in the speaker's mind, there is always a possibility that what they say will be misunderstood by the listener and produce an effect different from the one intended. All these variables are central to **Speech Act Theory**, where a "speech act" is defined by reference to the speaker's intentions (the **illocutionary** act) and the effects it produces in the listener (the **perlocutionary** effect) (David Crystal, 1981, P201). Generally, according to (Cummings, 2005), pragmatics is considered an interdisciplinary field of study that aims to investigate the processes of meaning production and their effects, taking into account the context of linguistic interactions (Guillaume Duboisdindien, Catherine T. Bolly, Anne Lacheret-Dujour, 2015, P2). Pragmatics is defined as the study of how speakers and listeners use language in specific contexts to communicate non-declarative meanings (i.e., meanings that go beyond what is encoded in the language) (Cummings, 2008, P11). The development of pragmatic and social skills is necessary for effective communication (Cummings, 2008, P166).

Inferential Reasoning: While language consists of explicit utterances whose meaning is directly accessible, it often contains implicit utterances, whose comprehension requires interpretation by the interlocutor. This necessitates the intervention of inferential processes, which allow interlocutors to "understand each other verbally even if the

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information is not explicit." Therefore, for comprehension to be complete, the interlocutor must form hypotheses to arrive at the appropriate and correct interpretation. These hypotheses are based on cues derived from the utterance itself, the context, the speaker, and also from shared world knowledge and conversational maxims (Gibbs, 1999). The inference is the result of all these processes and is positioned between pragmatics and logic. The ability to make these conclusions is termed 'inferential reasoning.'

Inferential reasoning requires significant cognitive resources. It demands the integration of various verbal and non-verbal pieces of information and involves diverse and complex processes. Accordingly, it requires a set of higher cognitive skills, most importantly **executive functions**, **Theory of Mind (ToM)**, **working memory**, and **attentional processes**.

Metaphor: Metaphor is defined as the use of a word (or term) outside its true (literal) original meaning, conditional on the presence of linguistic evidence and cues that necessitate a link between the *tenor* (the subject) and the *vehicle* (what it's being compared to). Aristotle defines metaphor as: "the transfer of a name from one thing to another, either from genus to species, or from species to genus, or from species to species, or by analogy" (Mohamed El-Wali, 2020, p30). Metaphor was considered an abbreviated comparison or simile, i.e., a similarity between two phenomena: A is B, meaning C is to D, as in Aristotle's example: "The cup is to Dionysus what the shield is to Ares." By analogy, the cup can be called "Dionysus's shield." Metaphor also allows for the connection of two concepts, translating one into the other, e.g., "Man is a wolf" (Charlotte

Dilks, 2011, P2). As a rhetorical figure, it results from transferring the usual significance of a word to another meaning, which is supposed to establish a typical similarity between two concepts. For the linguist R. Jakobson, both metaphor and metonymy play important roles in lexicon construction regarding language development, especially aspects related to verbal comprehension. In some linguistic disorders (developmental, acquired), metaphor is impaired (FredriqueBrin, 2004, P55).

Alzheimer's Disease (AD): Alzheimer's is a form of senile dementia appearing in older adults, characterized by rapid mental deterioration, memory disturbances, then complete dementia accompanied by language disorders, apraxia, muscular hypertonia, and sometimes epileptic seizures. Pathologically, it affects the cerebral cortex, especially the temporo-parieto-occipital regions, the hippocampus, and the ventricles (Jacques Quevauvilliers et al., 2009, p 36). It is a neurological disorder, a type of dementia, characterized by progressive degeneration of neurons in the cerebral hemispheres, accompanied by mental deterioration and personality disorders. It is caused by tangled masses of neurofibrils (NFTs) and Senile Plaques in the neurons, spreading particularly in the hippocampal, amygdaloid, and parietal lobe regions (Ulfat Hussein Kahla, 2012, p 233). Therefore, it is an acquired neurodegenerative disorder characterized by deficits in cognitive abilities, especially memory, and disturbances in behavior, personality, language, and social skills.

2. The Cognitive Approach to Metaphor Comprehension:

Sperber and Wilson are considered pioneers of cognitive pragmatics. They emphasize the human ability to possess

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and attribute mental states to others (ToM), to represent them, and to make inferences (draw conclusions from them), i.e., the ability to reason. For them, understanding utterances depends on all the meanings conveyed by the speaker, many of which are non-explicit (implicit). The main principle for this interpretation is the **Principle of Relevance**, derived from Grice's conversational maxims of relevance. Sperber and Wilson consider that both linguistic and non-linguistic conversational exchanges are subject to the same processes and must, therefore, be analyzed in the same way. Thus, Sperber and Wilson's theory falls within the comprehensive study of cognitive processes, and pragmatics, according to this orientation, is positioned within the cognitive sciences (Martine BRACOPS, 2010, P105).

Sperber and Wilson's view of the processes involved in understanding linguistic exchanges is explained through their adopted hierarchical representations of how the human mind functions during information processing, and through it, language comprehension. The Sperber and Wilson model also relies on the theory of mental modules, or **Modularity of Mind**, by the American philosopher and cognitive psychologist Jerry Fodor. He argues that: since mental representations can serve as word meanings, they must share certain properties with them. He then deduces from the apparent similarity between the structure of thoughts and the structure of sentences the hypothesis of a **Language of Thought (LoT)** (or *mentalese*). Mental representations have linguistic structures, and thinking relies on mental logic: the language of thought is to the mind what machine language is to the computer. According to this model, information processed by the human mind first passes

through **peripheral systems** (which include linguistic analysis) before reaching the **central system** (which handles pragmatic analysis). Peripheral analysis processes are considered specialized decoding processes, while central analytical processes are specialized inferential processes. These inferences are spontaneous, instantaneous, and unconscious. This orientation clearly establishes the comparison between the functioning of the human mind and the operation of a computer. This **mind-computer metaphor** is precisely the common denominator among the cognitive sciences, ensuring their unity. These disciplines (cognitive psychology, linguistics, neuroscience, computer science, artificial intelligence) view thought as an information transformation system, and cognitive pragmatics, in this regard, maintains privileged relationships with other cognitive sciences (Martine BRACOPS, 2010, P113).

According to J-L.Nespoulous and colleagues, comprehension occurs at the level of phonetic decoding centers, and subsequently at the level of linguistic decoding centers, which include lexical, semantic, and pragmatic processing. Thus, the perception of verbal and written stimuli occurs first, followed by the recognition of the 'signifier' (form) with activation of working memory, and finally, access to the 'signified' (meaning) or mental representation, involving long-term memory systems (semantic and episodic) (Eugénie Temporal, 2013, p41).

L. Denoix also showed that the production of an utterance's meaning, according to J-F Le Ny, depends not only on the linguistic properties of the utterance but also involves pragmatics in a specific context, in addition to the receiver's semantic and episodic memory systems and their effects (Eugénie Temporal, 2013, p40). According to Sperber

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and Wilson, the scope of linguistic analysis of an utterance is very narrow, limited only to establishing the logical form of the utterance. In contrast, the scope of pragmatic intervention is very broad, encompassing explicit and implicit meanings and contextual relations, intervening instantaneously in the interpretation of the utterance (Martine BRACOPS, 2010, P113). Therefore, understanding a message is a complex cognitive task requiring the involvement of many processes. It is evident, according to A. Borrell, that the final interpretation of the message requires the activation of other forms of processes that allow abstraction from the direct and explicit form of the message to infer non-explicit (implicit) information. This is the case for understanding metaphors and metonymies, which specifically requires abstracting from the explicit (literal) content (Eugénie Temporal, 2013, p41). Consequently, metaphor comprehension necessitates the activation of several cognitive functions, starting from linguistic (grammatical) processing and semantic composition, extending to **executive functions** involved in deriving an interpretation that goes beyond the literal meaning expressed by the sentence (Carlos Roncero, and Roberto G. de Almeida, 2014, P1).

This is supported by the findings of Klooster, McQuire, Grossman, McMillan, Chatterjee, &Cardillo (2020), which indicated multiple aspects of cognitive weakness in metaphor comprehension. This deficit is not attributed to a specific lesion in a single brain region but to a **distributed network** of neural processes including: semantic memory, working memory, execution of semantic tasks, **inhibition**, cognitive flexibility, and abstract thinking. An impairment in

any of these processes is likely to lead to a disorder in metaphor processing. The same study confirmed that one of the main factors explaining impaired metaphor comprehension is a deficit in the process of **inhibition (suppression)**. The inhibitory demands for understanding figurative meanings pose a cognitive challenge for them, as understanding the metaphorical meaning requires inhibiting the literal interpretation of the sentence or the familiar features of the metaphorical source to access the correct figurative meaning (Gernsbacher& Robertson, 1999; Papagno, 2001). Analysis of the control sample (healthy individuals) revealed that this cognitive inhibition also poses a challenge for them; both study samples (healthy and patients with neurodegenerative diseases including AD) chose the literal meaning in most incorrect trials, but the error rate for patients was higher, indicating greater difficulty in inhibiting the literal interpretation, and thus, a greater weakness in executive control.

Impaired inhibition is also linked to verbal fluency index scores, which in turn correlate with the accuracy of metaphor comprehension. Furthermore, understanding metaphorical sentences requires higher cognitive flexibility, as properties of one cognitive domain are applied to another. Cognitive flexibility is negatively affected by comprehensive neurological disorders, including neurodegenerative ones (Eslinger, Moore, Anderson, & Grossman, 2011; Kehagia, Barker, & Robbins, 2010; Swartz, Stuss, Gao, & Black, 2008).

3. The Neurological Basis of Metaphor Comprehension:

The highest manifestations of human thought and feeling are dynamic and active processes, reflected in constantly changing and adaptive relationships between the brain,

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body, and environment. Thought and feeling are states of neural activation resulting from complex interactions between the world, the body, the brain's neural and hormonal structure, and its accumulated memory over thousands of years of cultural acquisition (Michelle BOURASSA, 2006, P9, as cited in Dominique Neyrod, 2018, P43).

Thus, the entire life of thought appears as an active process, and at the base of brain activity lies**neuronal mobility**. Regarding language, the neural message is transmitted indirectly through axons, which are nerve fibers extending from cell bodies, connecting **Broca's area** (responsible for learning and controlling speech motor movements) and **Wernicke's area** (a primary center for decoding linguistic auditory messages), and the **inferior parietal lobule** (which plays an essential role in language comprehension alongside other parts of the brain). In addition to this 'neuronal nomadism' (neural pathway), there are other forms of movement represented by **dialectical connections**: between the immediate and the stored within language comprehension processes, where a confrontation occurs—at the level of the left inferior parietal lobule—between current linguistic information (usually auditory or visual) and previous traces of linguistic and non-linguistic events; and between the old and the new, as is the case with the phenomenon of emotions and metaphors.

Seana Coulson's "Metaphor Comprehension and the Brain" (2008) provided an analysis of the neural foundations of metaphor comprehension by reviewing a range of neuropsychological studies and brain imaging techniques. She concluded that metaphor comprehension involves a

complex network of brain regions, with a primary role for the **Left Hemisphere (LH)** and a re-evaluation of the **Right Hemisphere's (RH)** role.

Although the Right Hemisphere (RH) was once considered the "subordinate hemisphere," it later became clear that linguistic disorders were also associated with damage to this hemisphere. While **Left Hemisphere Damage (LHD)** leads to severe linguistic disorders, **Right Hemisphere Damage (RHD)** leads to specific disorders related to the relationship between speech and its communicative context. At the level of language production, the discourse of patients with RHD is characterized by socially inappropriate language, tangential speech, and straying from the topic, alongside a clear impairment in the use of non-verbal communication (Joanette, Goulet, &Hannequin, 1990).

Experimental studies on language comprehension have shown that these patients face difficulties in understanding jokes (Bihrle, Brownell, & Gardner, 1986; Brownell et al., 1983) and in interpreting sarcastic statements (Giora et al., 2002; Rehak et al., 1992). They are also characterized by the **literal interpretation** of figurative language (Winner & Gardner, 1977).

Thus, the LH is associated with processing the formal aspects of language, such as phonological, syntactic, and semantic analysis; while the RH plays a role in processing pragmatic aspects, those considered "supra-linguistic" or communicative (Seana Coulson, 2008, P178).

Studies have varied on the role of the cerebral hemispheres in non-literal language, including metaphors. Some highlighted a distinct role for the RH (Bottini et al., 1994; Brownell, Simpson, Bihrle, Potter, & Gardner, 1990;

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Winner & Gardner, 1977). Proponents of this view hypothesize that the RH plays a special and important role in the ability to understand metaphors, believed to be more involved in comprehending **novel and unfamiliar metaphors** (Bohrn, Altmann, & Jacobs, 2012; Mashal& Faust, 2009; Mashal, Faust, &Hendler, 2005). Later, interest in the LH's role in metaphor comprehension began to grow. Functional imaging studies showed that areas in the LH are involved in metaphor comprehension alongside areas in the RH (Bambini, Gentili, Ricciardi, Bertinetto, &Pietrini 2011; Cardillo, Watson, Schmidt, Kranjec, &Chatterjee, 2012; Chen, Widick, &Chatterjee, 2008; Lee &Dapretto, 2006; Obert et al., 2014; Schmidt &Seger, 2009; Yang, Fuller, Khodaparast, &Krawczyk, 2010), and perhaps play a primary role (Diaz, Barrett, &Hogstrom, 2011; Rapp, Leube, Erb, Grodd, &Kircher, 2004, 2007).

Meta-analyses of functional imaging studies led to the hypothesis that metaphor comprehension depends on a **bilaterally mediated process** (Bohrn et al., 2012; Rapp, Mutschler, &Erb, 2012; Reyes-Aguilar, VallesCapetillo, & Giordano, 2018; Yang, 2014). These studies showed that the **bilateral inferior frontal gyri (IFG)** and specifically the **left posterior middle temporal gyrus (LpMTG)** are activated during metaphor comprehension (Klooster, N., McQuire, M., Grossman, M., McMillan, C., Chatterjee, A., &Cardillo, E., 2020, P475).

Studies on patients with focal lesions in the LH revealed evidence of a specific impairment in their metaphor comprehension, despite preserved literal sentence comprehension (Cardillo, McQuire, &Chatterjee, 2018; Gagnon, Goulet, Giroux, &Joanette, 2003; Ianni, Cardillo,

McQuire, &Chatterjee, 2014; Tompkins, 1990). These studies suggest the involvement of the left prefrontal cortex and posterior temporal cortex in metaphor comprehension (Cardillo et al., 2018; Zaidel, Kasher, Soroker, &Batori, 2002).

The study by Klooster et al. (2020) confirmed the role of the LH in metaphor comprehension. Neurodegeneration patients confined to the LH showed deficits in understanding *familiar* metaphors. Functional imaging evidence also points to regions in the LH used by the healthy brain to understand metaphors (Bohrn et al., 2012; Rapp et al., 2012; Yang, 2014). This study, along with others (Cardillo et al., 2018; Gagnon et al., 2003; Ianni et al., 2014; Tompkins, 1990), highlighted the important and essential role of regions in the LH in metaphor comprehension in healthy individuals. Metaphor comprehension was correlated with the thickness of the **left posterior middle temporal gyrus (LpMTG)** and the **left inferior frontal gyrus (LIFG)** (Zempleni, Renken, Hoeks, Hoogduin, & Stowe, 2007; Davis et al., 2007). The left temporal lobe region and the LIFG are associated with processing the semantic complexity of literal language, and these same regions are involved in metaphor comprehension, as the latter shares properties with understanding polysemous words or complex sentences, most importantly, arriving at the appropriate and precise meaning. Both the LpMTG and LIFG were associated with deficits in metaphor comprehension, consistent with previous neuroimaging studies in the field (Cardillo et al., 2012; Chen et al., 2008; Lee &Dapretto, 2006; Schmidt &Seger, 2009; Yang et al., 2010). The LpMTG region is associated with semantic processing in general (e.g., Noonan, Jefferies, Visser, &Lambon Ralph, 2013).

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Seana Coulson (2008) emphasized that effective communication between the two hemispheres is crucial for metaphor comprehension. A study by Paul et al. (2003) indicated that patients with **agenesis of the corpus callosum (ACC)** suffer from significant impairment in understanding implicit, non-literal language. The performance of these patients is similar to RHD patients in choosing literal interpretations, highlighting the key role of inter-hemispheric interaction in understanding metaphors and figurative language (Seana COULSON, 2008, P184).

Neurophysiologically, Seana Coulson (2008) mentioned that the **N400 component** of Event-Related Potentials (ERPs) is a sensitive indicator of **semantic integration** difficulty (Kutas&Hillyard, 1980). Research by Coulson and Van Petten (2002) showed that the N400 amplitude for metaphors is affected by the complexity of conceptual mapping and blending processes. This supports the idea that LH regions, responsible for these complex cognitive processes, play a fundamental role in metaphor comprehension (Seana COULSON, 2008, P181-182).

4. Metaphor Processing in Alzheimer's Disease:

Studies, including Amanzio, Geminiani, Leotta, Cappa (2008) and Papagno (2001), have shown differences between the comprehension of novel and conventional metaphors in a sample of AD patients. It was found that they do not suffer from impairments in understanding *conventional* (old) metaphors. In contrast, studies using multiple-choice or target-matching tasks found impairments in figurative language comprehension, including metaphor, in patients with mild-to-moderate AD (e.g., Chapman et al., 1997;

Rassiga et al., 2009). These are the same findings reached by Winner and Gardner (1977) and Maki et al. (2012), which used tasks presenting the literal interpretation alongside the figurative one. They attributed this to the difficulty AD patients face in **inhibiting the literal meaning** to select the figurative one. However, when tasks require producing free verbal explanations for familiar figurative expressions, the performance of AD patients often does not differ from that of healthy individuals (e.g., Papagno, 2001; Amanzio et al., 2008).

In a study by Carlos Roncero and Roberto G. de Almeida (2014), which aimed to assess the comprehension of declarative, familiar, and *apt* metaphors in AD patients, they asked the study sample (experimental and control) to provide interpretations for various metaphors and similes. They found no differences between metaphors and similes within each group, but AD patients provided weaker metaphorical explanations compared to controls. This deficit in AD patients is attributed to two main factors: the patient's ability to **abstract** and the **aptness** of the metaphor.

Thus, most studies indicate that as the disease progresses, AD patients suffer from impairments in understanding novel and unfamiliar (i.e., non-rigid) metaphors. The severity of the impairment increases when the features shared by the vehicle and the topic are less salient, and when the level of aptness between the elements is low. Most studies have attempted to explain these disorders by primarily citing higher cognitive disorders, largely affecting **executive functions**. This was confirmed by the results of most studies, including Amanzio et al. (2008), which found a relationship between performance on novel metaphor comprehension and performance on the 'Key Search' item

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(measuring visuospatial planning) from the Behavioural Assessment of the Dysexecutive Syndrome (BADS). This indicates that executive functions play a role in the task of understanding novel metaphors in AD patients (Wilson et al., 1996).

Neuropsychological and neurophysiological studies have examined the neural basis of this cause (impaired cognitive control). Studies similar to visuospatial planning—such as the 'Tower of Hanoi' test (Fincham, Carter, van Veen, Stenger, & Anderson, 2002) and the 'Tower of London' (Lazeron et al., 2000)—showed bilateral activation of the **dorsolateral prefrontal cortex (DLPFC)**. One study using the 'Tower of London' task revealed important roles for the right and left frontal lobes; the right frontal lobe is significantly involved in planning, while the left frontal lobe executes the plan (Newman, Carpenter, Varma, & Just, 2003). Additionally, a recent fMRI study of the same task showed activation in the right ventrolateral prefrontal cortex and the left rostrolateral prefrontal cortex (Wagner, Koch, Reichenbach, Sauer, & Schlosser, 2006). Therefore, it is assumed that the 'Key Search' test within the BADS battery excites a similar neural network.

Among the most important executive functions confirmed by studies to be involved in determining the level of metaphor comprehension in patients with neurological injuries and degenerative diseases in general, and AD in particular, is the one that explains the difficulty in understanding novel metaphors as a deficit in **inhibiting** potential meanings that do not fit the linguistic context. Inhibiting contextually incompatible meanings may play an essential role in language comprehension, especially

metaphor comprehension (Gernsbacher& Robertson, 1999). Neuropsychological models attribute the function of inhibition to the **Supervisory Attentional System (SAS)**, as described by Norman and Shallice (1986), a concept close to Baddeley's**Central Executive** (1986).

The same study (Amanzio et al., 2008) also showed the importance of **verbal reasoning** in metaphor comprehension, evident through the relationship between performance on verbal judgment tasks and both novel and conventional metaphors. This function is also centered in the prefrontal cortex (Keil, Baldo, Kaplan, Kramer, & Delis, 2005). Several studies have revealed impairments in reasoning and problem-solving abilities in AD patients, specifically a deficit in recognizing similarities between objects or concepts (Huber, Shuttleworth, &Freidenberg, 1989; Martin &Fedio, 1983; Pillon, Dubois, Lhermitte, &Agid, 1986), understanding proverbs (Kempler, van Lancker, & Read, 1988), and the ability to make inductive inferences (Cronin-Golomb, Rho, Corkin, &Growdon, 1987; Waltz et al., 2004). Human lesion studies, along with functional neuroimaging studies, show that the prefrontal cortex is necessary for both reasoning and problem-solving processes (Koechlin et al., 1999; Waltz et al., 1999). Specifically, the ability to integrate and relate different types of information may grant a flexible representational structure to the prefrontal cortex, which is important for the fluid and innovative thinking that is fundamental to successful reasoning and problem-solving (Prabhakaran, Narayanan, Zhao, &Gabrieli, 2000). Some researchers have indicated that inductive reasoning is an executive function and under the control of attentional mechanisms (Brown & Marsden, 1991, 1988; Taylor, SaintCyr, & Lang, 1986).

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All forms of immediate thinking, from processing to sentence comprehension, require the temporary processing and storage of information. This essential role is assigned to **working memory**. Frontal regions play a special role in integrating different types of information within working memory.

The relationship between **metacognitive abilities** and metaphor comprehension tasks aligns with the **executive dysfunction hypothesis** (Perner& Lang, 1999). Studies have shown that the improvement of belief-desire processing (ToM) with cognitive development is linked to the maturation of executive selection functions (German & Leslie, 2000, 2004; Leslie, German, &Pollizi, 2005). This was confirmed by a recent study (German &Hehman, 2006) conducted on elderly individuals suffering from impaired belief-desire processing. It is likely that the impairment in belief-desire based thinking in old age results from an age-related decline in executive selection skills, which complement the basic mental state representational abilities, rather than a failure in the representational system itself. However, the relationship between metacognitive abilities and non-literal comprehension in AD patients is not limited to novel metaphors but also extends to conventional ones (Martina Amanzio, GiulianoGeminiani, Daniela Leotta, Stefano Cappa, 2008, P8).

The study by Carlos Roncero and Roberto G. de Almeida (2014) also pointed to the role of the **ability to abstract** in the metaphor comprehension process. It is a necessary cognitive process to go beyond the lexical meanings of words in search of shared features that explain the possible relationship between two linguistic referents. Although any

two linguistic units can be linked (e.g., both being physical objects, or existing on Earth), identifying appropriate relationships requires careful analysis to determine which feature *P* can be attributed to both *x* and *y* such that *P(x)* and *P(y)* are true. According to the same researchers, **aptness** is the motivating variable that facilitates this process in metaphor comprehension. An apt metaphor is one in which features from the "vehicle" are attributed to salient features in the "topic." The basic mental process here is to identify the appropriate features from the "vehicle" that can be attributed to the "topic," either by retrieving typical attributes stored in memory or by generating them mentally *de novo* and then attributing them to the topic, to generate an interpretation of the metaphor. Consequently, the study by Roncero& de Almeida (2014) concluded that the ability to rely on properties associated with aptness depends on the extent to which the individual retains their abstraction abilities. If this ability is intact, patients can interpret metaphors correctly. In contrast, individuals suffering from greater impairment in abstraction show difficulty in constructing appropriate interpretations for metaphors. However, if the level of abstraction required to understand the metaphor is low, it is possible even for individuals with deteriorated abstraction abilities to show near-normal levels of comprehension (Carlos Roncero, and Roberto G. de Almeida, 2014, P11).

5. Study Methodology:

Our study is based on examining the level of metaphor comprehension in patients with Alzheimer's Disease (AD). Accordingly, we were required to follow a descriptive-comparative methodology.

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5.1. Study Limitations:

- **A. Temporal Limitations (Time Frame):** From 03/15/2025 to 06/28/2025.
- **B. Spatial Limitations (Location):** The field study was conducted at the Elderly and Disabled Persons' Home in the Salah Bey district and the Functional Rehabilitation Center in Ras El Ma, Setif Province.

5.2. Study Sample:

The study sample consisted of two groups. The first group (experimental group) included 11 individuals suffering from Alzheimer's Disease. The second group (control group) consisted of 15 healthy elderly individuals (normal aging).

5.3. Sample Characteristics:

The first study group (AD group) was selected using a purposive sampling method, by selecting six individuals from the nursing home and five from the rehabilitation center based on the following criteria:

- Elderly persons aged 65 years or older.
- Individuals diagnosed with memory disorders.
- Individuals suffering from Alzheimer's Disease – moderate stage (Stage II).
- Willingness to interact to ensure the smooth application of the tools.
- Belonging to the same linguistic environment (Arabic speakers).
- Individuals of bothgenders.

- Not suffering from other neurological injuries, diseases, or disabilities.

In addition to a second group of normally aging elderly individuals (control group) who met the following specifications:

- Age 65 years or older.
- Do not suffer from Alzheimer's Disease.
- Do not suffer from other neurological disorders or disabilities.
- Belonging to the same linguistic environment as the study sample (Arabic speakers).
- Individuals of bothgenders.

5.4. Tools Used in the Study:

We relied on a set of tools in this study, represented as follows:

A. The Medical File:

We relied on medical files for sample selection. The following conditions were observed:

- According to the medical file, the sample individuals suffer from **moderate-stage (Stage II) Alzheimer's Disease**.
- According to the health file, the study sample does not suffer from any neurological diseases or injuries other than AD, or other diseases that could affect the study results.
- According to the medical file, the study sample does not suffer from severe hearing problems or other disabilities that could affect the study results.

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B. Tests:

1. The Mini-Mental State Examination (MMSE):

Translated into Arabic and adapted to the Algerian environment by Professor Farida Taâguelmimt. The test was developed by Folstein et al. (1975) to test cognitive abilities and assess the severity of disorders. It is one of the most widely used tests in the clinical field. It is administered individually in a quiet room and presented as follows:

- **Objective:** To assess cognitive functions and determine the degree of their impairment.
- **Materials:** A white sheet of paper, a pencil, and an eraser.
- **Examinee:** An adult with an elementary level of education or higher.
- **Instruction:** "I will ask you some questions to test your memory. Some are easy, and some are less easy. Try to answer them as best as you can."
- **Content:** The MMSE contains 11 items: Temporal Orientation, Spatial Orientation, Registration, Attention and Calculation, Recall, Naming, Repetition, Oral Comprehension, Reading Comprehension, Writing, and Drawing (Copying).
- **Scoring:** The test score ranges from 0 to 30 points. One point is given for each correct answer and 0 for a wrong answer. A score of 23 or less is considered an indicator of cognitive impairment, according to Flemming's classification for the severity of cognitive disorders:
    - **0-17:** Severe cognitive impairment (severe dementia).

- **18-23:** Mild cognitive impairment (mild dementia).
- **24-30:** No dementia.

2. MetaphorComprehension Test:

This is a test that measures an individual's ability to understand the meaning of metaphorical expressions. The idea for its construction was inspired by the metaphor comprehension test by Cardillo, Schmidt, Kranjec, &Chatterjee (2010); Cardillo, Watson, &Chatterjee (2016). This test was constructed with the help of an Arabic language professor, a group of university professors, and specialized speech-language pathologists (orthophonistes). The conditions that had to be respected in constructing this tool were:

- The metaphors should be somewhat **familiar (conventional)** and well-understood.
- Content word frequency and clarity must be respected.
- They should be less "imagistic" (less picturable) than their literal counterparts, meaning more figurative.

Finally, we obtained a series of expressions including **10 implicit metaphors (metonymic/metaphorical predicates)** and **10 explicit (declarative) metaphors**. The tool is applied individually between the examiner and the examinee.

- **Test Administration Conditions:**
  - Ensuring the examiner and examinee are alone in normal conditions, in a well-lit room free from sounds to prevent distracting the examinee's concentration.
  - The examinee sits comfortably facing the examiner, who presents the expressions,

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articulating the words correctly to facilitate comprehension.

- **Test Presentation:** This activity consists of series divided into two groups. The first group includes expressions in the form of implicit metaphors, and the second group in the form of declarative metaphors. Two trial items are provided for practice for each group.
- Instruction:
  Before starting each part of the test, the examiner presents two trial items with the following directions:
  - The first trial expression is presented to the examinee, and they are asked to explain the phrase and what they understood from it. By saying:
    - "Listen, I will say some phrases to you, and you have to tell me what is meant by them."
  - We present the first trial expression and explain it.
  - After ensuring the examinee understands the instruction (the trial item), the examiner begins presenting the rest of the expressions one by one.
  - **Note:** An example can be given if the examinee does not understand the instruction.
- Scoring:
  One point (1) is given for each phrase when the examinee provides a correct answer, i.e., gives an interpretation of the phrase, even if the answer is

approximate, as long as it confirms a good understanding of the phrase.

- **CalculationMethod:** Total implicitmetaphors (10 points) + Total declarativemetaphors (10 points) = 20 points.

5.5. Statistical Analysis of the Study:

In the current study, we relied on:

1. **Descriptive Analysis:** To calculate frequencies and percentages.
2. **Inferential Statistics:** Given the small sample size of the study, we relied on the **non-parametric Mann-Whitney U test** for two independent samples. Wealsoused the SPSS statistical program.
3. Effect Size: The effect size formula r=Z/N
   Where:
   - **Z** is the statistical value resulting from the Mann-Whitney test.
   - N is the total number of participants in both groups.
     According to established standards (Cohen, 1988):
   - $0.1 \le r < 0.3$: Small effect size
   - $0.3 \le r < 0.5$: Medium effect size
   - $r \ge 0.5$: Large effect size

6. Presentation and Analysis of Study Results

Regarding the tests applied to establish the sample characteristics:

For the first group (AD Group): The table below shows the frequency and percentage distribution of the study sample's

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characteristics (Alzheimer's patients). The results were derived from reviewing the sample's medical files and the MMSE test.

Table 01: Frequency and Percentage Distribution of the Alzheimer's Patient Sample Characteristics (N=11)

Characteristic	Category	Frequency (N=11)	Percentage (%)
Age	65 years and older	11	100
Gender	Male	4	36.4
	Female	7	63.6
Education Level	Primary	4	36.4
	Middle School	2	18.2
	Secondary	3	27.3
	University	2	18.2
Marital Status	Married	8	72.7
	Divorced	2	18.2
	Widowed	1	9.1
Place of Residence	Urban	4	36.4
	Semi-urban	3	27.3
	Rural	4	36.4
MMSE Results	0-17: Severe cognitive impairment (Severe dementia)	0	0

Characteristic	Category	Frequency (N=11)	Percentage (%)
	18-23: Mild cognitive impairment (Mild to moderate dementia)	11	100
	24-30: No dementia	0	0
Medical Aspect	Presence of comorbid neurological diseases (Parkinson's, etc.)	0	0
	Presence of neurological injuries	0	0
	Presence of comorbiddisabilities	0	0

The table shows that all sample members (100.0%) are over 65 years old, which is consistent with the nature of research, related to Alzheimer's Disease. The sample is distributed between males (36.4%) and females (63.6%). In terms of educational level, the primary education category constitutes the largest percentage (36.4%), followed by those with a secondary level (27.3%), while the percentages for middle school and university education are equal (18.2% each).

The results show that the majority of the sample (72.7%) are married. Regarding the place of residence, 36.4% of the

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sample members reside in urban areas and 36.4% in rural areas, while semi-urban areas account for 27.3%.

Concerning the cognitive aspect, the **MMSE results** showed that all sample members (100%, N=11) fall within the category indicating "mild to moderate cognitive impairment" (between 18 and 23 points). This confirms the sample's **homogeneity** in terms of dementia severity and makes it suitable for the study's target population.

Based on a review of the sample members' health files, it was confirmed that the sample is entirely free from comorbid neurological diseases (such as Parkinson's), neurological injuries, or comorbid disabilities (0% for each category). This means that variables that could affect the study's results were **excluded**.

- **For the second group (Control Group):** The table below presents the frequency and percentage distribution of the characteristics of the healthy control sample, derived from the MMSE test.

Table 02: Frequency and Percentage Distribution of the Healthy Control Sample Characteristics (N=15)

Characteristic	Category	Frequency (N=15)	Percentage (%)
Age	65 years and older	15	100
Gender	Male	9	60
	Female	6	40
Education Level	Primary	4	26.7
	Middle School	3	20
	Secondary	5	33.3

Characteristic	Category	Frequency (N=15)	Percentage (%)
	University	3	20
Marital Status	Married	12	80
	Divorced	1	6.7
	Widowed	2	13.3
Place of Residence	Urban	7	46.7
	Semi-urban	4	26.7
	Rural	4	26.7
MMSE Results	0-17: Severe cognitive impairment (Severe dementia)	0	0
	18-23: Mild cognitive impairment (Mild to moderate dementia)	0	0
	24-30: No dementia	15	100
Medical Aspect	Presence of comorbid neurological diseases (Parkinson's, etc.)	0	0
	Presence of neurological injuries	0	0
	Presence of comorbiddisabilities	0	0

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The table shows that all members of the (control) sample (100.0%) are over 65 years old. The healthy study sample is distributed between males (60.0%) and females (40.0%). In terms of educational level, the secondary education category constitutes the largest percentage (33.3%), followed by primary education (26.7%), and both middle school and university levels (20.0% each). The majority of individuals (80.0%) are married. Regarding place of residence, nearly half of the individuals (46.7%) reside in urban areas, while the remaining percentage is distributed equally between semi-urban and rural areas (26.7% each).

Regarding the Mini-Mental State Examination (MMSE), the results showed that all sample members (100%, N=15) fall within the category indicating "No dementia" (scores between 24 and 30). This confirms the sample's homogeneity, indicating they are free from severe or moderate cognitive impairments.

Medically, the results indicate the sample is entirely free from comorbid neurological diseases (e.g., Parkinson's), neurological injuries, or comorbid disabilities (0% for each category). Consequently, the most significant variables that could affect the study's results were excluded.

Presentation and Analysis of the Hypothesis Results:

The hypothesis states that: **"There are statistically significant differences between the group of Alzheimer's patients and the healthy controls in metaphor comprehension."**

To verify this hypothesis, we adopted the **non-parametric Mann-Whitney U test** for two independent samples. This test was used to determine the significance of the differences

between the mean ranks of the two study groups on the study variable (metaphor comprehension).

Table (03): Illustrates the mean rank and sum of ranks for the members of the two study groups on the level of metaphor comprehension.

Table 03 : Ranks Statistics (Mean Rank and Sum of Ranks) for Metaphor Comprehension by Group

Variable	Group	N	Mean Rank	Sum of Ranks
Metaphor Comprehension	Alzheimer's Patients	11	10.18	112
	HealthyControls	15	15.93	239
	Total	26		

The table above shows the descriptive Rankstatistiques for the performance of the two groups on the metaphor comprehension test. The sample size for the Alzheimer's patients was 11 individuals (N=11), with a **mean rank** of **10.18** and a **sum of ranks** totaling **112.00**. In contrast, the healthy control group consisted of 15 individuals (N=15), with a **mean rank** of **15.93** and a **sum of ranks** totaling **239.00**.

These descriptive statistics indicate that the mean rank performance of the healthy individuals on the metaphor comprehension test was higher than the mean rank performance of the Alzheimer's patients. This disparity in mean ranks reflects a difference in the level of performance between the two groups, with the healthy controls tending to achieve higher levels of metaphor comprehension.

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Table 04: Mann-Whitney U Test Statistics for Metaphor Comprehension

Test Statistic	**Value**
Mann-Whitney U	46.000
Wilcoxon W	112.000
Z	-1.972
Sig. (p-value)	0.049
Effect Size (r)	-0.3867

The table above shows that the Mann-Whitney U test statistic was **46.000**, and the Z-value was **-1.972**. Regarding the p-values, the asymptotic significance (Asymp. Sig.)is**0.049**, which is below the standard alpha level of $\alpha=0.05$. This indicates a **statistically significant difference** between the two groups.

The effect size value ($r = -0.387$) indicates a **medium effect size**. This means the difference in metaphor comprehension performance between the Alzheimer's patients and the healthy controls is not only statistically significant but also has clear practical significance. The negative direction indicates that the group with the lower ranks (the Alzheimer's patients) accounts for this effect.

7. Discussion and Interpretation of the Hypothesis Results

The current study aimed to assess the level of metaphor comprehension in Alzheimer's Disease (AD) patients. The study hypothesis posited the existence of statistically significant differences between the two study samples (AD

patients and healthy controls), **and the hypothesis was confirmed**.

Although we used **familiar (conventional) metaphors**—meaning they are derived from the daily linguistic environment and their processing relies on retrieval rather than construction—the results of this study **contradict** those reached by studies such as Amanzio et al. (2008). That study, which aimed to find differences between novel and conventional metaphor comprehension in AD, found *no impairment* for conventional metaphors. The researchers attributed the impairment in *novel* metaphor comprehension (compared to conventional) to modern explanatory models which assert the role of **executive functions (EFs)** and **inferential abilities** in processing novel metaphors, whereas these functions are not involved in processing conventional metaphors.

(Conventional metaphors are those so integrated into daily speech they have lost their figurative nature, e.g., "my head exploded from thinking"). Their processing is automatic, like explicit language, and does not require special cognitive intervention, as their meaning is stored in the high-frequency lexicon, making them "frozen" or stored as a complete unit. This aligns with Papagno (2001), which used a *free explanation task* (unlike previous studies using multiple-choice) and found no comprehension differences between early-stage AD patients and controls. That study used familiar, old, and frequent metaphors, which could be considered highly "salient" according to the Graded Salience Hypothesis (GSH). Therefore, their processing was direct, accessing the lexicon automatically associated with the input, and did not require the abstract-inferential processes involved in novel metaphors. Processing conventional

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metaphors relies on general cognitive functions, and accessing semantic knowledge may be sufficient. They require limited intentionality and attentional control, as shown by the lack of correlation between conventional metaphors and EF tasks. Conversely, understanding novel metaphors (which are not in the lexicon) may require additional processes, such as retrieving information from episodic memory, accessing mental imagery, and verbal processing (Mashal et al., 2005).

Therefore, **cognitive control**—an important function for guiding activity, especially without a prior cognitive schema—is necessary when processing novel metaphors. Impaired central executive functions lead to an inability to map the figurative element (vehicle) onto the topic (tenor) to create a new similarity. This is the same concept adopted even by models that do not differentiate between old and new metaphors. For example, the **"Class Inclusion Theory"** (which suggests metaphors are understood by seeing the topic as part of a broader category represented by the vehicle) posits that metaphors are understood as taxonomic units (Glucksberg&Keysar, 1990). This categorization process likely demands more executive resources for novel metaphors than conventional ones. Similarly, **Conceptual Metaphor Theory** (Lakoff& Johnson, 1980) suggests metaphors transfer information from a concrete to an abstract domain. These can be conventional (stored) or novel (not stored), the latter also requiring executive resources.

However, the current study **aligns with** studies that used multiple-choice or match-to-target tests, which *did* show impaired figurative language comprehension in mild-to-moderate AD (Chapman et al., 1997; Rassiga et al., 2009).

These are the same findings as Winner and Gardner (1977) and Maki et al. (2012). These results were explained by the nature of the task: presenting the literal interpretation alongside the figurative one causes AD patients difficulty in **inhibiting (suppressing)** the literal interpretation in favor of the figurative one.

We can explain this discrepancy in results by referring to the nature of the metaphorical expressions used in this study. Although they were familiar and conventional, they were a **mix of implicit metaphors (metonymic/predicate metaphors)**—where the vehicle is omitted and implied by one of its attributes (an action or quality)—and **explicit (declarative) metaphors**—where the vehicle is explicitly stated.

Both differ not only in linguistic form but also in cognitive (and thus neuropsychological) processing. The explicit metaphor is less cognitively complex because it facilitates comprehension and reduces cognitive load. Its comprehension relies heavily on simple semantic processing, managed mainly by **Left Hemisphere (LH)** language networks (Rapp et al., 2011). In contrast, the **implicit metaphor poses a greater challenge** as it requires deeper inferential processes; the vehicle is omitted, leaving the listener to deduce it from context. This complex cognitive process activates regions in the **Right Hemisphere (RH)**, especially the right prefrontal cortex, which is necessary for contextual integration and inference (Mashal et al., 2005).

Studies indicate that implicit metaphors require more cognitive effort because the listener must infer the vehicle, whereas explicit metaphors provide this information (Chiappe et al., 2003; Roncero& de Almeida, 2014). This is confirmed by most speech-language pathology

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(orthophonie) studies: linguistic structures that are clearer and focus on explicit relations are less complex than those requiring implicit inference of a deleted element, as in the implicit metaphor.

Because implicit metaphors require inferring non-obvious relationships, they are more susceptible to comprehension impairment in AD patients (Amanzio et al., 2008). Studies show AD patients struggle to inhibit literal meanings, especially in indirect or cognitively complex metaphors (Winner & Gardner, 1977; Papagno, 2001). Papagno (2001, P1458) noted that metaphors involve an "active search for the specific semantic attribute" more than other figurative types. Therefore, the **weakening of semantic memory networks** (Chertkow& Bub, 1990) hinders the patient's ability to retrieve the necessary meanings to understand the implicit metaphor, making them more prone to misunderstanding it compared to explicit metaphors, which offer clearer cues. This distinction supports Papagno's (2001) finding that "forms of trope that demand a heavier effort... are more challenging" for this patient group, providing a strong basis for interpreting our findings.

Given the nature of AD, characterized by progressive decline in cognitive functions (especially semantic memory, attention, and EFs), and since metaphor comprehension is a composite skill... any impairment in these areas can be reflected in metaphor performance. The current results can be explained in light of these neuro-cognitive and linguistic specificities. Although the expressions were carefully selected to be familiar and common in the local vernacular, the difficulties shown by AD patients reflect a direct deficit in the ability to perform **abstraction** and construct non-

literal meanings. Furthermore, verbal tests (relying on oral explanation) may exacerbate the patients' linguistic deficits, given the constraints the disease places on verbal fluency and syntactic organization.

The impaired comprehension of *explicit* metaphors in AD patients may also be due to an abstraction deficit. Roncero& de Almeida (2014), who assessed familiar and apt explicit metaphors, found AD patients provided weaker figurative interpretations than controls. This deficit was attributed to two factors: the patient's ability to **abstract** and the **aptness** of the metaphor. That study showed semantic aptness was a decisive variable; some patients could interpret *unfamiliar* metaphors, provided they were *highly apt* (Roncero& de Almeida, 2014, P13).

Conclusion:

The neural basis of metaphor comprehension is essential for understanding language processing models and for defining therapeutic needs. Studies on neurological patients show impaired metaphor processing (Yang et al., 2010), including in Parkinson's (Fernandino et al., 2013) and Alzheimer's (Amanzio et al., 2008; Papagno, 2001; Roncero& de Almeida, 2014; Winner & Gardner, 1977). Figurative skills are affected in Mild Cognitive Impairment (MCI) (Cardoso, Silva, Maroco, de Mendonça, &Guerreiro, 2014) and AD (Papagno, Lucchelli, Muggia, & Rizzo, 2003). These studies confirm that metaphor comprehension is likely a particularly **vulnerable (weakly structured) linguistic skill**.

The current study's results align with Klooster et al. (2020), which showed AD patients suffer from metaphor

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comprehension impairment. That same study concluded that metaphor task performance might be an important **indicator of cognitive decline** in neurodegenerative diseases affecting the medial temporal lobe, such as AD (Klooster et al., 2020, P488).

Therefore, metaphor comprehension could be a **sensitive indicator** of cognitive dysfunction in neurodegenerative diseases like Parkinson's, Frontotemporal Dementia (FTD), and AD (Klooster et al., 2020, P476).

The lack of a clear correlation between patient performance on metaphors and traditional cognitive tests, as shown in previous studies (Amanzio et al., 2008), proves that current neuropsychological tests do not adequately assess non-literal language deficits. We join previous calls (Rapp & Wild, 2011) for the necessity of **including non-literal language tasks in neuropsychological assessment batteries**.

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