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Review Article

# Metaphor Skills in Deaf and Hard of Hearing Individuals: A Systematic Review

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## Highlights

- Metaphor skill is vital for effective communication and social interaction
- Assessing metaphor skill in DHH individuals is essential for educational strategies

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## ABSTRACT

**Background and Aim:** Metaphor is a vital element of human communication, facilitating the expression of complex ideas and emotions. However, little is known about metaphor in individuals who are Deaf or Hard-of-Hearing (DHH). This systematic review addressed a critical knowledge gap by providing the first comprehensive synthesis of methodologies used to study metaphor competence in individuals who are DHH. It aimed to build a cohesive understanding by examining the types, characteristics, and limitations of the tasks employed, which have not been previously aggregated and analyzed.

**Recent Findings:** An initial search of 331 articles was narrowed to 53 after removing duplicates and screening titles. An additional 10 articles were found through supplementary searches. After a full-text review, 29 articles were excluded for being irrelevant outcomes or language, leaving 24 eligible studies for the final analysis. 926 DHH and 1234 normal hearing participants were analyzed. Results revealed considerable variability. While some studies report no significant differences between DHH and hearing individuals, others indicate that DHH individuals have difficulties with metaphor, especially with complex or novel forms.

**Conclusion:** This review provides the first comprehensive overview of metaphor competence in DHH individuals, revealing its multidimensional nature and the impact of multiple linguistic and developmental factors. It underscores the need for targeted research and the creation of suitable assessment tools to inform educational and clinical practices, supporting improved metaphor comprehension and use in DHH populations.

**Keywords:** Metaphor; figurative language; deaf and hard-of-hearing; task; systematic review

## Introduction

Metaphor, which may be regarded both as a linguistic and a cognitive phenomenon, represents a key role in human communication through conveying complex ideas and emotions. These figurative expressions [1, 2] are based on similarities which are allegedly unrelated, but cognitively justified, allowing abstract ideas to be realized through more concrete terms [3]. The essential role of metaphor in communication lies in expressing the concepts which may not be expressed by the literal language [4-6]. Metaphorical ability, therefore, provokes articulating emotions, enhancing creativity and critical thinking. This ability requires inferential thinking together with social and cultural awareness [7, 8].

Considering the need for advanced cognitive and linguistic skills to understand metaphors [1, 2], researchers have increasingly focused on how the Deaf or Hard-of-Hearing (DHH) individuals acquire and process metaphorical language. Studies confirm that hearing loss impacts both verbal and non-verbal communications [9, 10], especially when visual cues are eliminated due to factors such as face masks [11], and despite the technological advances [12] and early interventions, many pre-lingual DHH individuals still face language challenges [13]. These include difficulties in understanding connotative meanings, which are generally more challenging to comprehend than denotative meanings, identifying conceptual similarities or differences, and finally, interpreting the speaker's intent [7, 14], alongside limited vocabulary, grammar, and speech processing abilities [15, 16].

Such challenges lead to several complications in the comprehension of metaphor, which basically requires complex cognition. Reduced exposure to linguistic and non-linguistic inputs, along with semantic limitations and inference or working memory deficits, further hinder metaphor understanding in the DHH [7, 17]. The impact of hearing loss on metaphor skills extends beyond language, affecting social interactions and potentially leading to misunderstandings, isolation, and mental health issues [18, 19].

Although these observations suggest difficulties in terms of understanding the metaphors among the DHH, existing studies present mixed findings. Variables such as cognitive capacity, hearing loss characteristics, treatment methods and timing, and communication context (auditory, visual, or multimodal) may influence metaphor perception. Therefore, exploring metaphor skills in the DHH and identifying factors behind the inconsistencies in research findings can help in developing effective intervention strategies.

This systematic review aimed to investigate metaphor skills in DHH individuals and addresses the following research questions:

*Research Question 1:* Do DHH individuals perform differently from those with normal hearing in metaphor-related tasks, and what factors (e.g., age, hearing loss severity, cognitive/language abilities) influence their performance?

*Research Question 2:* What tasks and properties are used to assess metaphor skills in individuals who are DHH?

## Methods

### Search strategy

The process of designing and presenting this systematic review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines [20]. Our protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO) under the Cochrane Collaboration (CRD42024475680). A comprehensive and methodical search was conducted across the following databases: PubMed, WoS, JSTOR, Scopus and EMBASE for all published studies up to December 20th, 2024 utilizing combination of following search terms: "hearing loss", "hearing impair*", "hearing disorder*", deaf*,"cochlear implant*", "hearing aid*", and "abstract concept*", innuendo, metaphor*, allusion, "figurative language*", "imagery metaphor". To ensure that all relevant and credible sources were included in the search process, our search covered the gray literature using different search engines and checking all included article references.

## Study inclusion criteria

Eligible articles reported significant findings on outcomes such as results on the performance of metaphorical tasks. The target population included individuals with any ages, type and degree of hearing impairment, including prelingual hearing loss. Only original peer-reviewed research articles, including control trials, retrospective studies, cohort studies, cross-sectional studies, case reports, and case-control studies, were considered. Exclusions were made for non-English articles, review articles, letters to editors, editorials, as well as the unavailable full texts. Inclusion criteria on the basis of Participants, Intervention, Comparison, Outcomes, and Study (PICOS) strategy are provided.

P: individual with any ages, type and degree of prelingual hearing impairment
I: any assessment including test and task related to metaphor skill
C: no control group
O: any result related to metaphor skill or related tasks
S: any original peer-reviewed research articles

## Screening process

During the initial screening of titles and abstracts, two independent raters (F.F., Z.M.) were involved. The team also undertook a thorough assessment of the full text. Any discrepancies that arose were subsequently resolved by A.N through a secondary review in a meeting to ensure a high level of accuracy and consistency in the assessment of the material. The PRISMA flow diagram (Figure 1) illustrates the selection process. A pilot analysis of four articles by two researchers (A.B., F.F.) yielded a data extraction file. The standardized data extraction was used to collect authorship, publication year, study design, participant demographics, and other relevant variables. These variables included the metaphor tasks, additional evaluations such as the

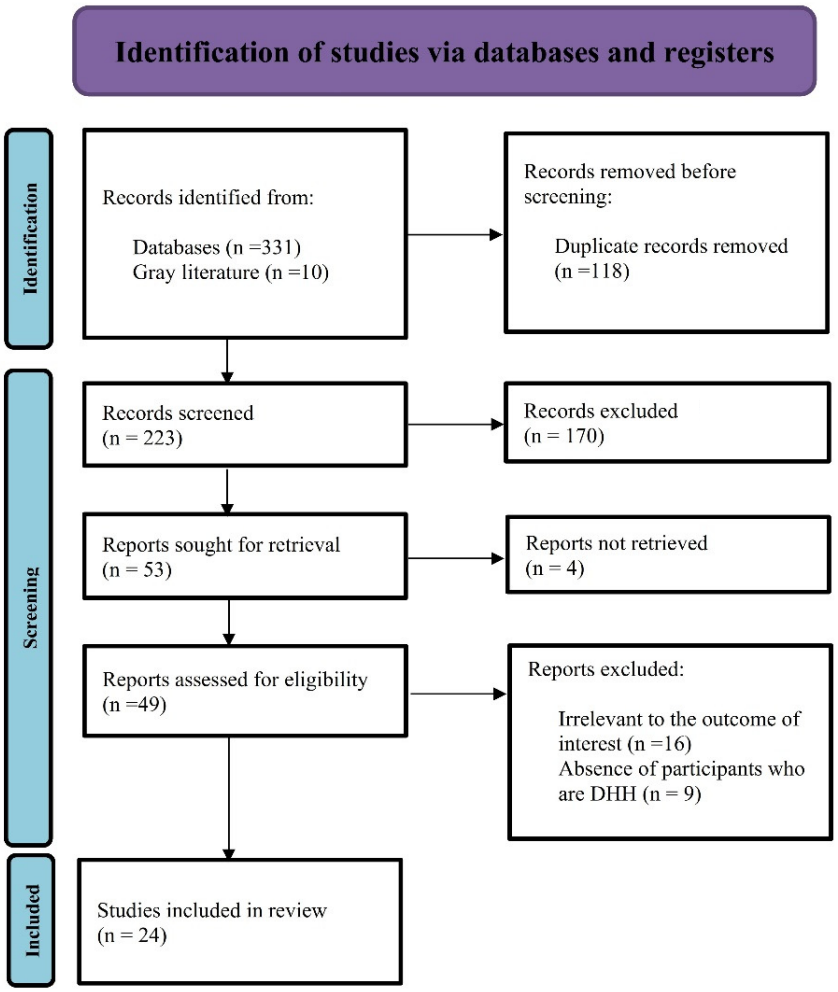


**Figure 1.** PRISMA flow diagram

**Table 1.** Characteristics for all included studies for the participants, metaphor task properties, aim and main findings of each study

| Study | Language | Population (number, age and gender) | Metaphor task properties | | | | Main findings | Risk of bias |
|---|---|---|---|---|---|---|---|---|
| | | | Modality of presentation (i.e., visual, auditory, or written tasks) | Presentation level (word, sentence, story) | Number of items | Response format (multiple choice, short answer, verbal explanation or a combination of these methods) | | |
| Kawar et al. [41] | Palestinian Arabic | 61 participants gender: both gender | Auditory | Short stories based on a depicted atmosphere | One story | Explanation | • Higher C-unit scores in normal-hearing, especially females.<br>• Figurative scores higher in normal-hearing.<br>• Females showed more "frame of mind" and hedges. | Fair |
| Hilviu et al. [42] | Italian | 42 participants, 6–11 years old gender: both gender | Visual and auditory | Sentences | Metaphor subtest from APL Medea included 8 items: 4 VM, and 4 FM | Explanation for VM and multiple choice for FM | • CI children weaker in pragmatics, especially conversation.<br>• Nonverbal IQ correlates with pragmatic skills.<br>• Early CI not sufficient for typical development. | Good |
| González-Cuenca and Linero [38] | Spanish | 58 participants, 10–19 years old gender: not reported | Visual | Story | Two experimental probes and three control items | Explanation (sign language if needed) | • Deaf had no problem recognizing nonverbal cues, but struggled with inferring intention.<br>• ToM and language linked to nonverbal understanding.<br>• Emphasized training on intention attribution. | Good |
| Edwards et al. [7] | English | 74 participants, 18–24 years old gender: not reported | Visual | Sentence | 17 Questions | Multiple choices | • Deaf students outscored hearing in metaphor tasks.<br>• No difference between CI and non-CI users.<br>• Better verbal skills and memory improved figurative comprehension. | Fair |
| Soltani et al. [40] | Persian | 5 participants, 5–7 years old gender: not reported | Audio and audio-visual | Sentences in audio-visual tasks and story in audio tasks | 39 items | Multiple choices | • Hearing-impaired children struggled with abstract and embodied conceptual metaphors.<br>• Strongest difficulties in ages 5–7.<br>• Sensorimotor deprivation impacts comprehension. | Good |
| Bahrami et al. [39] | Persian | 35 participants gender: not reported | Audio visual | Sentence | Two metaphorical expressions for anger, happiness, and fear concepts | Multiple choices | • CI children understood metaphors less than normal-hearing.<br>• Lower language skills; need for more speech/language training. | Good |

**Cintinued Table 1.** Characteristics for all included studies for the participants, metaphor task properties, aim and main findings of each study

| Study | Language | Population (number, age and gender) | Metaphor task properties | | | | Main findings | Risk of bias |
|---|---|---|---|---|---|---|---|---|
| | | | Modality of presentation (i.e., visual, auditory, or written tasks) | Presentation level (word, sentence, story) | Number of items | Response format (multiple choice, short answer, verbal explanation or a combination of these methods) | | |
| Gold and Segal [17] | Hebrew | 36 participants gender: both gender | Visual (written) | Word | 240 Word pairs plus 32 word pairs not used in the main list. | Judging between choices by pressing the corresponding key | • Deaf adults' metaphor performance similar to hearing.<br>• Slower responses for novel metaphors.<br>• Early intervention and hearing aids crucial. | Good |
| Gu et al. [35] | Mandarin Chinese | 15 participants gender: not reported | Visual/written | Sentence | Two tasks | Interpreting and performing | • Mandarin proficiency improved time metaphor interpretation in deaf signers.<br>• Cross-modal metaphors impact spatio-temporal reasoning.<br>• Language shapes cognitive reasoning skills. | Fair |
| Nicastri et al. [14] | Italian | 31 participants gender: not reported | Visual and auditory | Sentences | Metaphor subtest included 8 items: four verbal metaphors (VM), four figured metaphors (FM) | Explanation for VM and multiple choice for FM | • CI children with good language = similar to hearing in many tasks.<br>• Persistent difficulty with metaphors.<br>• More incomplete responses to linguistic metaphors. | Good |
| Giang et al. [37] | Vietnamese | 215 participants gender: both gender | Visual, written | Sentence | Fifteen idioms and proverbs per test plus three idioms and proverbs of lower grades to figurative language knowledge, in higher grades | Multiple choices | • Hearing-impaired children scored lower on figurative language.<br>• Language skills improved by grade, not age/hearing level.<br>• Figurative language linked to reading skill. | Good |
| Kunisue et al. [36] | Japanese | 75 participants, 1–14years old gender: not reported | Phonetically and visually (pictures) | Word | Six pictures | Selecting a suitable picture matching the word | • Hearing-impaired scored lower on abstract vocabulary, but improved over grades.<br>• No qualitative difference in vocabulary acquisition. | Good |
| Wolgemuth et al. [24] | English | 25 participants gender: both gender | Written for verbal metaphor tasks including comprehension, preference, and completion of figurative language expressions visual and pictorial form for visual metaphor task | Sentence-level for completion and preference tasks story-level for comprehension tasks | 16 items per task (comprehension, preference, and completion tasks) and 29 sets of three pictorial stimuli for visual metaphor task | Multiple choices for comprehension and preference tasks short answer for completion task and selecting choices with verbal explanations for visual metaphor task | • No significant group difference in metaphor tasks.<br>• Both groups better at frozen than novel metaphors.<br>• Degree of hearing loss may impact language ability. | Fair |

**Cintinued Table 1.** Characteristics for all included studies for the participants, metaphor task properties, aim and main findings of each study

| Study | Language | Population (number, age and gender) | Metaphor task properties | | | | Main findings | Risk of bias |
|---|---|---|---|---|---|---|---|---|
| | | | Modality of presentation (i.e., visual, auditory, or written tasks) | Presentation level (word, sentence, story) | Number of items | Response format (multiple choice, short answer, verbal explanation or a combination of these methods) | | |
| Rittenhouse et al. [25] | English | 27 participants, 13–65 years old gender: not reported | Visual-processing tasks for visual metaphor task. The tasks included metaphor tasks, which required analogical reasoning rather than linguistic mediation, emphasizing higher-order cognitive abilities. | Story | Ten metaphor tasks. One image with four different explanations for each item. | Multiple choices | • Hemispheric interactions affect cognition per theory.<br>• No differences in academic/language skills among groups.<br>• Hearing acuity did not impact academic outcomes. | Fair |
| Inman and Lian [23] | English | 20 participants, 7–18 years old gender: both gender | Visual (pictures) and written | Story | Ten stories plus two practice items | Multiple choices and explanation | • Positive link between metaphor understanding and cognitive conservation skills.<br>• Practice and feedback improve metaphor comprehension.<br>• Older students perform better. | Fair |
| Rittenhouse and Kenyon [26] | English | 35 participants gender: not reported | Visual (picture), written | Short paragraph | Series of metaphor vignettes composed of brief paragraphs, each containing less than 50 words | Multiple choices | • Need to address individual communication.<br>• Weak, positive link between conservation and metaphors.<br>• Cognitive skills can develop independent of language barriers. | Fair |
| Rittenhouse and Kenyon [29] | English | 20 participants, 13–16 years old gender: both gender | Visual (videotape), auditory (discussion). | Sentence | Sixteen | Multiple choices and short answer | • Combined traditional and media interventions boost idiom understanding.<br>• Improved comprehension and retention of figurative language. | Fair |
| Rittenhouse and stearns [28] | English | 12 participants, 3–12 years old gender: both gender | Written | Story | One story with 10 yes -no questions at the end of the story | Yes –no answers | • Figurative content in stories did not hinder reading.<br>• Deaf students comprehended literal and figurative equally.<br>• Teaching figurative expressions more effective than editing text. | Fair |
| Orlando and Shulman [30] | English | 19 participants, 9–19 years old Gender: not reported | Written | Sentence | Four series of stimuli, each containing five sentences | Multiple choice and explanation (sign language) | • HI students gave more abstract responses with higher reading levels.<br>• Language proficiency grew with improved reading. | Good |

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| Study | Language | Population (number, age and gender) | Metaphor task properties | | | | Main findings | Risk of bias |
|---|---|---|---|---|---|---|---|---|
| | | | Modality of presentation (i.e., visual, auditory, or written tasks) | Presentation level (word, sentence, story) | Number of items | Response format (multiple choice, short answer, verbal explanation or a combination of these methods) | | |
| Everhart and Marschark [31] | English | 15 participants, 12–15 years old gender: both gender | Sign/auditory | Created two stories based on two depicted atmospheres | Two | Oral, sign, written production | • Hearing students used more non-literal forms in writing; DHH more in sign.<br>• DHH showed greater flexibility with sign language. | Fair |
| Marschark et al. [33] | English | 20 participants, 7–15 years old gender: not reported | Auditory and visual (sign language) | Story | Two | Describing (sign language if needed) | • Deaf children displayed creative, figurative language use comparable to hearing.<br>• Demonstrated strong nonverbal and figurative communication skills. | Good |
| Rittenhouse et al. [27] | English | 23 participants gender: not reported | Written and visual (picture) | Story | Ten | Multiple choices | • NH children scored highest in metaphor stories, followed by oral-auditory, sign-speech, and manually-coded English groups.<br>• No significant group differences in metaphor comprehension or academic achievement.<br>• Sign-speech group performed best on retention tasks. | Fair |
| Marschark and West [32] | English | 12 participants gender: not reported | Sign/auditory | Created two stories based on two depicted atmospheres | Two | Sign and oral production | • No significant difference between deaf and hearing groups for novel metaphors or figurative language.<br>• Deaf (signing) students showed more creative and flexible nonliteral language than hearing peers.<br>• Similar story production length among groups. | Good |
| Marschark et al. [34] | English | 11 participants gender: not reported | Visual written and hand drawn pictures | Story | Twelve metaphor items | Multiple choices | • Hearing loss did not significantly impact conservation or metaphor understanding.<br>• Intelligence and age positively affected performance.<br>• Conservation skills strongly predicted metaphor comprehension.<br>• Alternative instructional approaches (clear instructions, feedback) improved performance. | Good |
| Iran-Nejad et al. [43] | English | 46 participants, 9-17 years old gender: both gender | Reading and signing stories and also visual (pictures) | Story | Twelve | Multiple choice and giving a reason for each selected practice item | • Deaf children performed well on metaphor tasks.<br>• Challenged the belief of special deficits in deaf children for metaphor comprehension.<br>• Practice and support enabled metaphor understanding. | Good |

APL Medea; language pragmatic abilities, VM; verbal metaphors, FM; figured metaphors, CI; cochlear implant, IQ; intelligence quotient, ToM; theory of mind, HI: hearing impaired, DHH; deaf and hard of hearing, NH; normal hearing

linguistic and cognitive tests. Also, the results of the evaluation of metaphor skills in the individuals who are DHH have been reported separately.

### Risk of bias assessment

The quality of the included studies was assessed using the National Institutes of Health's study quality assessment tools. Four reviewers independently evaluated the risk of bias for each individual study using the National Institutes of Health (NIH) quality assessment tools. These tools are designed to facilitate the categorization of studies as "good", "fair", or "poor"; depending on their respective study designs [21]. To be considered "good", at least 75% of the questions had to be answered positively, as previously suggested by Knapik et al. The agreement between the raters was high ($\kappa$=0.86, $p<0.05$) in the initial evaluation [22]. The majority of studies reviewed exhibited good quality, with a minimal risk of bias stemming from selection, information, measurement, or confounding factors. Notably, none of the studies employed randomization or blinding procedures. Full details of the assessment are presented in Table 1.

### Data synthesis

Due to the heterogeneity in research methods, participant inclusion criteria, and outcome measures across the studies, a descriptive synthesis was employed instead of a meta-analysis. The first author led the data extraction process, which was then verified by the second author. The agreement between the two was high, with a kappa statistic of 0.81 ($p<0.05$), and any discrepancies were resolved through consensus.

## Results

### Study selection

PRISMA diagram illustrates the systematic process of reviewing and selecting studies that met the inclusion criteria (Figure 1). The initial search yielded 331 articles from the databases specified in the methods section. After removing unrelated and duplicates (n=118), articles were screened based on titles and abstracts, resulting in 43 studies for full-text analysis. An additional 10 articles were added to the study through supplementary searches and a review of references cited by articles discussed during several research group meetings. The conflict error (less than 3%) was noted among the two reviewers during the initial screening stage, which was subsequently resolved through discussion with the research group supervisor. Subsequently, nine articles were excluded due to the absence of participants who are DHH, 16 articles were irrelevant to the outcome of interest, and four others were excluded due to unavailability of full English text. Following this process, 24 studies met the eligibility criteria and were retained for further analysis (Table 1).

### Study characteristics

The included studies were conducted in various languages and countries: English [7, 23-34], Chinese [35], Japanese [36], Vietnamese [37], Spanish [38], Persian [39, 40], Arabic [41], Hebrew [17], and Italian [14, 42]. Participants ranged in age and degree of hearing loss, from mild to deaf. Some studies compared DHH individuals with those with normal hearing; others focused solely on the DHH population. Across all studies, 2160 participants were involved (926 DHH and 1234 hearing). Task types varied, with many studies also incorporating assessments to explore correlations with metaphor performance. A few focused exclusively on metaphor tasks.

### Population characteristics

The demographic details of the participants and the supplementary findings from the reviewed studies are shown in Figure 2.

### Age and gender

Participant ages ranged from children to adults. Twenty-two studies examined DHH individuals aged 5–19 English [14, 23-43], while two studied adults over 19 [7, 17]. Most studies (58.3%) included both genders [7, 14, 17, 26, 28, 29, 31-33, 37-43], one focused only on females [35], and 37.5% did not report gender.

### Hearing loss and the assistive listening devices

The degree of hearing loss in the studies varied from mild [24, 26, 34] to deaf [7, 14, 32, 38]. They used different hearing assistive devices, including hearing aids [24, 26, 29, 40], and cochlear implants [17, 38, 39, 42], and the rest of the studies used both of them. This variability was crucial, as it allowed for providing

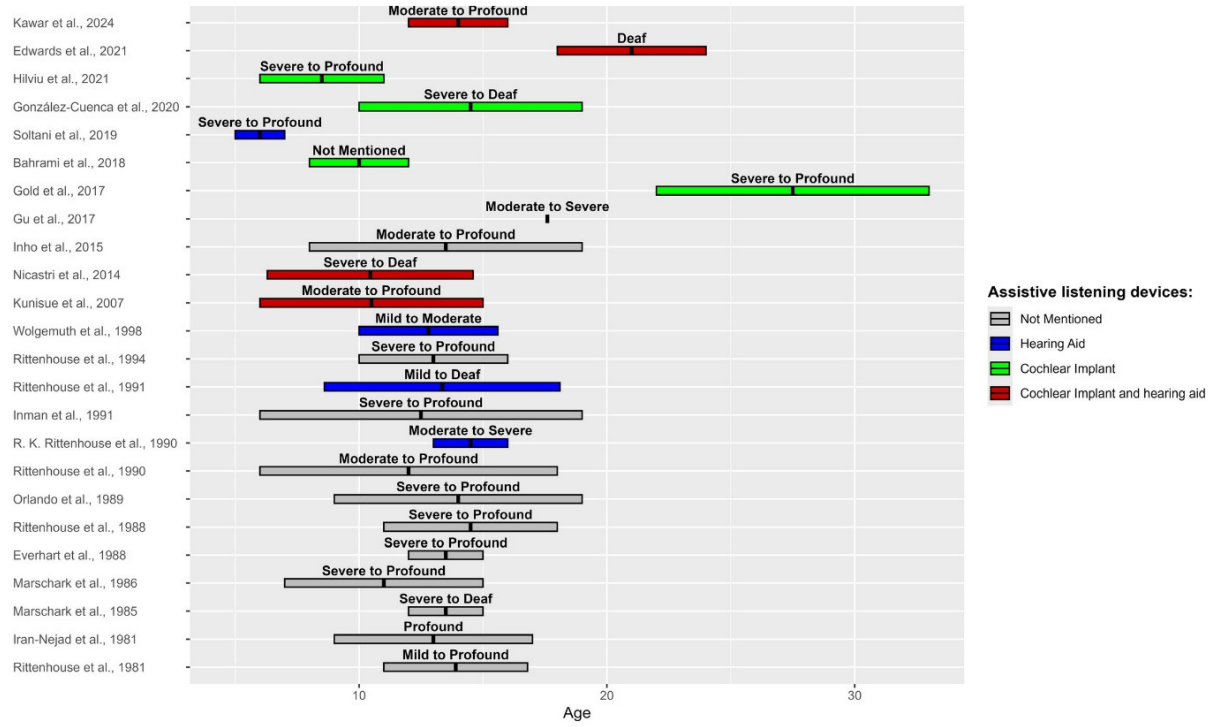


**Figure 2.** Characteristic of participants

insights of how different levels of hearing loss impact metaphor skills.

## Communication modalities

Communication modalities among individuals who are DHH can vary depending on their hearing impairment severity and individual factors. As the modalities of communication were different in the participants of the reviewed studies. For instance, in the studies of [14, 23, 24, 27, 39-41] individuals who are DHH communicated verbally, but in [7, 31, 33, 43] studies, sign language was a primary means of communication among individuals who are DHH. Furthermore, cued speech was used by [31, 33] to communicate. In conclusion, this review suggests that individuals who are DHH employ a range of communication strategies to compensate for their auditory limitations.

## Metaphorical tasks

This section reviews the metaphor tasks used across studies, which varied in items number, content, complexity, presentation level (word, sentence, story), modality (visual, auditory, written), presence of training items, and response format (multiple choice, short answer, verbal explanation, or combinations). Most studies emphasized metaphor comprehension, while only a few explored spontaneous production [31, 32, 41]. Task characteristics are shown in Table 1.

The results presented in the table demonstrate a considerable variation in the number of items examined across studies, with the highest number of 240-word pairs [17], and the lowest number reported by Rittenhouse et al. [28].

Among the 24 reviewed articles, two studies employed words to investigate metaphor processing in their participants [17, 36]. Gold and Segal stated that their primary objective was to evaluate the processing of metaphorical skills with a focus on the semantic perspective, without consideration for contextual influences. In order to achieve this, two-word expressions were used as stimuli, rather than common sentences or stories [17] in other studies. Some studies [7, 14, 24, 29, 30, 35, 37, 39, 40, 42] employed expressions or sentence-level stimuli to examine metaphor comprehension in individuals who are DHH. A notable part of studies, 15 in total, utilized stories to investigate metaphors, which can indicate the superiority and advantage of this task for investigating metaphors in people with hearing

disorders [23-29, 31-34, 38, 40, 41, 43]. These findings collectively underscore the importance of considering the linguistic and contextual factors that may impact metaphor competence in individuals who are DHH.

Reviewed articles indicate that assessing of metaphorical skills has been investigated using various tasks, but a few tasks have robust validity and reliability. For instance, the Italian Standardized Battery of Pragmatic Language Skills task, employed in studies by Hilviu et al**.** and Nicastri et al, is a valid and reliable task for assessment of metaphor comprehension [14, 42]. Similarly, the Standardized Comprehension Test for Abstract Words (SCTAW) task, utilized in the study by [36], has been shown to be a reliable tool for assessing metaphorical skill. Additionally, Soltani et al.'s metaphor task has content validity [40], in the studies by Rittenhouse and Stearns [28] and Giang et al. [37] teachers' ratings were used to design the metaphorical tasks. In the studies by Gold and Segal [17], Orlando and Shulman [30] and Bahrami et al. [39], tasks were checked and judged by experts and adjudicators. Other studies used researcher-designed tasks based on the study's objectives and target population.

This review shows that metaphor tasks were delivered in various formats. Over half of the studies used visual stimuli such as images, sign language, or writing, or a combination [7, 17, 23-28, 30, 34-38, 43]. A few studies relied solely on auditory input [41], while others used both visual and auditory modalities [14, 29, 31-33, 39, 40, 42] Several studies [14, 17, 23, 24, 34, 40, 43] included pre-tests or training tasks before the main metaphor assessment. These were designed to explain the task format, improve understanding, and help participants provide accurate responses by reducing confusion. Response formats varied across studies: some used explanations [14, 23, 30-33, 38, 41, 42] while 15 studies employed multiple-choice or question-answer formats [7, 17, 24-30, 34, 36-40, 43]. Gold and Segal uniquely utilized a computer-based metaphor assessment, where participants judged whether two-word expressions conveyed literal, metaphorical, or no meaning, and included a reaction time analysis not found in other studies [17].

Most studies included cognitive and linguistic assessments alongside metaphor tasks to have a better understanding of the participants' abilities. Common tools included the Peabody Picture Vocabulary Test (PPVT), conservation tasks, and Intelligence Quotient (IQ) tests. For example, language tests were used in [14, 42], conservation tasks in [34], and additional evaluations in [23, 27]. These assessments consistently showed strong links between language proficiency and metaphor comprehension, with higher cognitive ability also supporting metaphor understanding.

## Hearing impaired individuals' proficiency in metaphorical tasks

To facilitate a comprehensive report of the 24 reviewed studies, the results can be categorized into three general groups as follows:

The first category includes studies that reported there is no difference in metaphor performance between individuals with and without hearing impairments. For instance, Kawar et al, study revealed that the scores for figurative expressions were higher in the hearing group compared to the hearing-impaired group, although this difference was not statistically significant [41]. González-Cuenca and Linero, study showed that deaf participants do not find it difficult to understand non-literal sentences, but they have difficulty in attributing the real motivation to the speaker [38]. Furthermore, Gold and Segal found that deaf youth demonstrated similar performance to their hearing peers in processing conventional metaphors, literal, and unrelated word pairs; however, they exhibited longer reaction times for novel metaphors, indicating increased effort in processing these types of metaphors compared to their hearing counterparts [17]. Wolgemuth et al. stated that no significant differences were found between the group of children who are DHH and the group with normal hearing on any of the metaphor comprehension tasks. Both groups demonstrated similar metaphor competence and response patterns on all tasks [24]. Rittenhouse et al. study comparing conservation and metaphorical abilities, found that the group with normal hearing had the highest performance, followed by the oral-aural group, the cued speech group, and finally the manually-coded English, although these differences were not significant. Therefore, there was no significant difference between hearing and hearing-impaired groups in metaphor comprehension [27]. Marschark et al, stated that children who are DHH produced as much figurative language in sign language as hearing children

produced in spoken English. This study suggests that deaf children have language and cognitive flexibilities that are comparable to those of hearing children [33]. This researcher in his previous study found that deaf individuals didn't exhibit significant differences in novel tropes and figurative language compared to their hearing peers [32].

The second category is the studies that clearly showed significant findings that highlight potential differences in metaphor performance of people who are DHH. Numerous studies have investigated the metaphorical abilities of individuals who are DHH compared to those with normal hearing. For instance, Hilviu et al. discovered that children with cochlear implants tended to perform weaker in pragmatic tasks, including metaphor comprehension, relative to their hearing peers [42]. Similarly, Edwards et al. concluded that the scores of hearing students significantly surpassed those of deaf students, while revealing no difference between implanted and non-implanted groups [7]. Soltani et al.'s study revealed that children who are DHH scored significantly lower than their hearing peers in metaphor comprehension tasks, suggesting that they tend to interpret metaphorical concepts literally and struggle to understand abstract metaphorical concepts [40]. Furthermore, Bahrami et al. found a significant difference between the metaphorical expression understanding of children with cochlear implants and those with normal hearing. Despite having undergone cochlear implantation, children with hearing loss demonstrated lower linguistic skills, particularly in terms of metaphor comprehension. They require additional speech and language training to address these deficits [39]. Nicastri et al. reported that children with unilateral cochlear implants and satisfactory language skills performed similarly in comparison with hearing children in most language tasks, but struggled to comprehend figurative language, particularly metaphors [14]. Giang et al.'s study demonstrated a weaker metaphorical performance in children who are DHH; they performed significantly lower than hearing children on a figurative language test across all grade levels [37]. Kunisue et al.'s study revealed that the hearing-impaired students had lower scores on the SCTAW compared to normally hearing peers [36]. Similarly, Orlando and Shulman 's study revealed that individuals who are DHH exhibited a weaker understanding of figurative language. This study also examined the influence of intelligence, reading skills, and age on performance [30]. Furthermore, Everhart and Marschark discovered that deaf students produced fewer non-literal constructions in written productions compared to their hearing peers, but their cued stories exhibited more non-literal structures than spoken stories from their hearing counterparts. Moreover, hearing students outperformed deaf students in novel trope comprehension [31].

Finally, the third category of studies did not include a control group and merely examined metaphor performance in individuals who are DHH. For example, Gu et al.'s study showed that signers with higher Mandarin proficiency were more likely to interpret figurative concepts, similar to the conventional spoken language. This suggests that even cross-modal metaphors, such as those found in language, can shape how people think about figurative language like space and time [35]. Additionally, in the study done by Rittenhouse et al. on deaf children, the results showed that hemispheric specialization and auditory ability may have a reciprocal effect on cognitive performance, particularly in understanding and interpreting figurative language, such as metaphor. In this study, statistically significant differences in favor of the left-ear group were found in the metaphor test, indicating that children with better auditory abilities in their left ear performed significantly better compared to the right-ear group. This study confirms that research on cognitive and linguistic abilities in children with severe to profound hearing loss is limited in number and often yields different results, requiring further studies [25]. In a previous study conducted in 1991, this researcher reported that individuals who are DHH exhibit a greater degree of language flexibility than initially anticipated [26]. Another study in this category is the study done by Inman and Lian, this study found a positive relationship between conservation and metaphor skills, implying that solutions to these problems may also be found in the classroom through training and feedback provided by tailored instruction. The performance of metaphor did not significantly vary with the number of years of specialized training, level of hearing loss, or type of communication modality. It was found that metaphor performance was significantly related to chronological age [23]. Rittenhouse et al. examined the reading of a story in two literal and figurative language conditions in participants who are DHH and found that they performed similarly in these conditions, indicating

that figurative language did not hinder reading comprehension as previously assumed. This suggests that educators should reconsider their approaches to teaching figurative expressions, as they may not be as detrimental to reading comprehension in children who are DHH as thought [28]. Similarly, Rittenhouse and Kenyon compared two methods of learning metaphorical concepts for deaf students i.e., media and discussion, emphasizing the importance of combining media use with traditional classroom discussions and follow-up activities suggested by children. This study shows that multimedia presentations created by teachers tailored to specific content and appealing to children can enhance learning [29]. Furthermore, Iran-Nejad et al. observed that hearing-impaired subjects surprisingly performed well in metaphor tasks, challenging the notion that deaf children have a specific deficit in understanding metaphors. They claimed that appropriate support and practice enable these children to understand and interpret metaphors [43].

These findings suggest that while there may be some variations in metaphor skills between individuals with and without hearing impairments, the results are not uniform, and do not support a clear conclusion about the extent to which hearing impairment affects metaphor skills.

## Discussion

This systematic review aimed to provide a comprehensive understanding of the current state of knowledge on metaphorical skills in individuals who are DHH. We attempted to answer two main research questions:

*Research Question1:* The findings of the reviewed studies showed that there is no consensus on whether individuals who are DHH have difficulty with metaphorical skills or not. Most findings suggest they face challenges in understanding or expressing metaphors. Influential factors include the severity and onset age of hearing loss, cognitive abilities, and language and social variables. For example, Edwards et al. found a positive link between working/short-term memory and understanding figurative language. They also reported better metaphor comprehension among those using spoken language as their primary communication method [7]. Stronger linguistic skills correlated with improved understanding of metaphors and irony. Additionally, a correlation was observed between verbal/nonverbal intelligence and pragmatic abilities, including metaphor skills [42]. Importantly, linguistic proficiency is not limited to spoken language; many DHH individuals demonstrate advanced language skills via sign language. Inman and Lian, identified further factors like a positive correlation between conservation skills, classroom attendance, cognitive understanding, and metaphor performance, which also increased with chronological age [23].

The study by Soltani et al. showed that severe hearing impairments tend to increase children's tendency to interpret metaphorical meanings in a real meaning (literal) rather than abstract and metaphorical concepts [40]. Age of cochlear implantation was identified as an additional important factor by Nicastri et al. which found that children who received cochlear implants at an early age had a better understanding of metaphors [14]. The results of Giang et al., study also showed that children who are DHH had a weaker understanding of metaphors, and their figurative language skills were related to reading levels [37]. These findings suggest that sensory input deficits may contribute to individuals who are DHH experiencing difficulties in comprehending conceptual metaphorical structures. Individuals who are DHH may struggle to comprehend texts and daily conversations accurately. Such errors may compromise their communication with others, leading to misunderstandings or even breakdowns in subsequent conversations [40]. As previous studies have demonstrated, severe hearing impairment almost completely disrupts various aspects of psychosocial development [44, 45]. Despite the emphasis of the studies of this section on the problems of individuals who are DHH in metaphorical skills, various factors have been identified as influential side factors that complicate the interpretation of how hearing impairment affects metaphorical skill.

However, there were also studies indicating that individuals who are DHH did not differ in their metaphorical performance. These findings included studies [24, 27, 43], which generally stated that hearing impairment is not a factor in differences between individuals with normal and impaired hearing [26] found a significant correlation between age and metaphorical tasks, as well as between age and conservation

tasks, indicating the important role of experience in understanding both tasks. None of the conservation tasks or metaphoric abilities were significantly related to the degree of hearing loss or communication state. Rittenhouse et al. examined the metaphorical performance of deaf children in reading two versions of stories under literal and figurative conditions and found that their performance was significantly above chance. This study's format limited its applicability due to its reliance on yes/no questions, which increased guessing probability, which is considered as a limitation of the study. This limitation reduces the generalizability of the findings [28]. Wolgemuth et al. found that children with mild to moderate hearing loss performed similarly to their hearing peers on verbal and visual metaphorical tasks, but these authors noted that confirming the relationship between degree of hearing loss and linguistic ability was difficult because language deficits in children with hearing loss could be due to basic processing mechanisms rather than just hearing loss. They also emphasized the need for further research on the relationship between degree of hearing loss and linguistic abilities in individuals who are DHH [24]. Some studies, such as Gold and Segal's article, found that individuals who are DHH can perform metaphorical tasks at a level similar to their hearing peers, but with a longer reaction time. However, this study is unable to generalize the results due to the neglect of the influence of context on the processing of various types of metaphors [17].

Despite existing research, important questions remain such as whether sign languages shape metaphor comprehension in DHH individuals. Further studies should examine how different communication styles influence the processing of semantic and metaphorical expressions among sign language users. Outstanding issues include whether DHH individuals use unique metaphorical expressions, if those with late-onset hearing loss interpret auditory metaphors differently from those born deaf. Variability in study findings may be due to methodological differences, participant characteristics, and the diversity of metaphor tasks and assessment tools, as discussed below.

*Research Question 2:* Tests and tasks are vital for identifying communication needs and developing appropriate interventions. While numerous tasks have been applied [46], few are standardized, limiting their relevance to the target population. Researcher-designed tasks can gain reliability and accuracy through validation by experts in hearing impairment. This is especially important for sign language users, as applying spoken-language metaphors without accounting for language differences may distort findings. Key factors affecting task design include presentation level, modality, and response format. Tasks ranged from single words to full stories. One study using word-level presentation aimed to minimize contextual effects and focus on semantic processing but acknowledged this approach as a limitation, noting that presenting metaphors out of context is unnatural [17]. In contrast, most studies used story-level presentations. Since metaphors often rely on comparing abstract and concrete concepts, lacking context may hinder understanding and lead to literal interpretation and confusion. Therefore, context plays a crucial role in metaphor processing, and future research should explore how various formats and modalities affect comprehension to better understand the underlying cognitive mechanisms.

A review of metaphor task modalities in various studies shows two main categories: visual and auditory. Visual formats benefit individuals who are DHH, as visual cues aid comprehension [47]. Tools such as images, video clips, and written texts help convey meaning more clearly and allow some detailed analysis of metaphor structure without relying on auditory input. This advantage stems from enhanced visual processing compensating for limited auditory access. Moreover, visual stimuli can reduce confounding variables like working memory demands. However, with written formats, metaphor difficulties might stem from reading issues rather than hearing loss, making it essential to assess reading skills beforehand. Auditory presentation may challenge DHH individuals due to processing difficulties, with factors like speech clarity, noise, and auditory ability influencing performance [48,46]. Some studies use a combination of visual and auditory modalities, which may enhance metaphor comprehension by offering multiple cues suited to varied sensory needs. It should be considered that some individual differences such as hearing loss severity, communication strategies, and cognitive skills, are crucial when modalities are selected. Further research is required for a better understanding of how different visual and auditory presentations affect metaphor comprehension in this population.

The response format used in metaphor tasks can influence the performance of individuals who are DHH. The most common formats are yes-no and multiple-choice questions, where participants select the intended metaphor from options presented via images, stories, or text. This method is favored for its simplicity, ease of explanation, straightforward scoring, and response analysis. However, offering both literal and metaphorical options may limit the interpretation performance, as it allows only a superficial analysis and does not clarify why a participant chose a specific answer. This also introduces the possibility of chance influencing responses and measurement error. To address this, some studies have asked participants to explain their choices [23, 24, 43].

For example, offering two options like "yes" or "no" in Rittenhouse and Stearns increased the effect of chance [28]. Less commonly used response formats in studies include verbal explanation and metaphor production. In verbal explanation tasks, participants interpret figurative language in their own words, revealing their understanding and re-expression skills. However, this format may be avoided in studies with DHH individuals due to their limited verbal abilities, as spoken language challenges could obscure true metaphor comprehension. Despite this, it offers more clarity in assessing understanding and sheds light on metaphor processing mechanisms. A few studies have explored metaphor production, where participants create their own metaphors, providing insights into cognitive processes and figurative language use in individuals who are DHH [31-33, 41].

Metaphor tasks can inform communication and educational strategies for individuals who are DHH. Integrating metaphor training into language learning may improve comprehension of figurative language and enhance social and academic outcomes. Task design should consider degrees of hearing loss and communication styles, as well as language and cultural influences. Item selection requires clear criteria, including age, hearing loss severity, communication mode, metaphor familiarity, intelligence, and language proficiency. A universal yet adaptable framework for task administration is needed, accounting for linguistic and cultural contexts. Such a framework would advance both clinical and theoretical research.

### Limitations

Our systematic review identifies the need for further research, given the several limitations in this field. These include the limited number of studies, diversity in study designs leading to inclusion of acceptable quality studies, and the restriction of the studies mainly to English-language publications. The studies also used different methodologies and metaphor tasks, which normally makes direct comparisons difficult. In addition, heterogeneity in the DHH population limited our ability to draw definitive conclusions about metaphor skills in individuals who are DHH.

## Conclusion

Metaphor comprehension, independent of the specific language in use, constitutes a fundamental aspect of effective communication and plays an integral role in individuals' social lives. Inadequate understanding of common metaphors may slow cognitive processing and lead to partial loss of critical communicative content. Given that individuals who are Deaf or Hard-of-Hearing (DHH) frequently experience unique barriers in both message reception and transmission, evaluating their metaphor comprehension is essential for informing the development of appropriate educational and supportive strategies.

Existing studies in DHH populations have produced contradictory findings highlighting both the complexity of the phenomenon and the need for continued empirical attention. The present systematic review underscores the importance of investigating the causes underlying these discrepancies. It is recommended that future systematic reviews specifically examine the effects of auditory deprivation on metaphor learning in individuals with hearing loss. Addressing these knowledge gaps through well-designed research will facilitate targeted interventions and contribute to a more nuanced understanding of metaphor processing within DHH communities.

## Ethical Considerations

### Compliance with ethical guidelines

This article is a systematic review with no human or animal sample. There were no ethical issues to be considered in this research.

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## Data Availability Statement

The datasets generated and/or analyzed during the current study are available upon reasonable request to the corresponding author.

## Authors' contributions

AN: Study conceptualization and design; BMB: Critical revision of the manuscript for important intellectual content, and final approval; FF: Literature search and screening, interpretation of the results, data extraction; AB: Literature search and screening, interpretation of the results, drafting the manuscript; MA: Data extraction; NM: Data extraction; RJ: Literature search, acquisition of full-text articles, and assistance in data extraction; SZM: Literature search and screening, interpretation of the result, data extraction, drafting the manuscript.

## Conflict of interest

The authors declared no conflict of interest.

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