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RESEARCH ARTICLE

Metaphor comprehension and production in verbally able children with Autism Spectrum Disorder

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Abstract

Research in the field of figurative language processing in Autism Spectrum Disorders (ASD) has demonstrated that autistic individuals experience systematic difficulties in the comprehension of different types of metaphors. However, there is scarce evidence regarding metaphor production skills in ASD. Importantly, the exact source of metaphor processing difficulties in ASD remains largely controversial. The debate has mainly focused on the mediating role of structural language skills (i.e., lexical knowledge) and cognitive abilities (i.e., Theory of Mind and executive functions) in ASD individuals' ability to comprehend and generate metaphors. The present study examines metaphor comprehension and production in 18 Greek-speaking verbally able children with ASD and 31 typically-developing (TD) controls. Participants completed two tasks, namely, a low-verbal multiple-choice sentence-picture matching task that tested their ability to comprehend conventional predicate metaphors, and a sentence continuation task that assessed their ability to generate metaphors. The study also included measures of fluid intelligence, expressive vocabulary, and working memory within the sample. The results show that the ASD group had significantly lower performance than the TD group in both metaphor comprehension and production. The findings also reveal that expressive vocabulary skills were a key factor in the metaphor comprehension and production performance of the children with ASD. Working memory capacity was also found to correlate significantly with metaphor comprehension performance in the ASD group. Conversely, no correlations were found in the TD group with neither of the above factors. Of note, children with ASD generated significantly more inappropriate responses and no-responses to the metaphor production task compared with the control group. The overall results reveal that children with ASD had difficulty with both comprehending and using metaphorical language. The findings also indicate that TD children may employ diverse cognitive strategies or rely on different underlying skills when processing metaphors compared with children with ASD.

Lay Summary

Difficulties related to metaphor comprehension are commonly observed in ASD individuals. However, less is known about metaphor production abilities in ASD. In this study, we compared metaphor comprehension and production skills in 18 verbally able Greek-speaking children with ASD and 31 TD children, and also examined the role of vocabulary knowledge and working memory in metaphor processing. The overall results show that both metaphor comprehension and production were more challenging for the children with ASD as compared with their TD peers. Furthermore, we found that vocabulary knowledge is a factor that significantly influences both metaphor comprehension and production performance of ASD participants. The study also reveals that metaphor comprehension abilities in children with ASD are based on working memory skills.

KEYWORDS
Autism Spectrum Disorder, error analysis, executive functions, figurative language, language skills, metaphor production, pragmatics, predicate metaphors

INTRODUCTION

Comprehension, generation, and proper use of language expressions with nonliteral meaning are key manifestations of pragmatic ability, which according to Cardillo et al. (2021) can be described as the ability to communicate and interact effectively with others in daily life, utilizing various qualities of context (i.e., linguistic, social, physical). Figurative (or nonliteral) language is typically defined as a range of linguistic expressions which convey an indirect nonexplicit meaning. For example, metaphors, verbal irony, similes, and idioms are some of the most representative subtypes of nonliteral language that can be framed in the broader context of pragmatics. In a more poetic and less conventional definition by Gibbs Jr. (1994), nonliteral language is a conscious and unprompted expression of our imagination and the way we perceive reality. From the above, it is obvious that difficulties in the comprehension and production of nonliteral meanings can have a negative impact on the domains of human communication and social interaction (Swineford et al., 2014). In terms of language development, in typically-developing (TD) children, the ability to process nonliteral utterances arises in early childhood and develops progressively into adulthood (Falkum et al., 2017). On the contrary, for atypical populations, such as children with Autism Spectrum Disorders (ASD), evidence exists of late acquisition and development of their nonliteral language processing skills (Melogno et al., 2012; Whyte & Nelson, 2015). This finding comes as no surprise given the general scientific consensus that figurative language comprehension is a quite demanding process that necessitates the activation of both cognitive and linguistic mechanisms (Dietrich, 2004; Glucksberg, 2001).

Metaphors are a distinctive form of nonliteral language, prevalent in everyday communication and thought (Katz, 2016; Lakoff & Johnson, 2003). They are innovative and often humoristic linguistic expressions whose use can be quite effective in the enhancement of ASD individuals' social skills (Ifantidou & Piata, 2021). Upon using a metaphor, we actually attempt to describe and highlight a particular semantic feature of a domain (i.e., the target domain) by addressing an implicit comparison with another conceptually distant domain (i.e., the source domain), which holds the same semantic feature (Colston, 2023). For example, in the metaphorical expression "My brother is a dolphin," the target domain (i.e., brother) is being compared with the source domain (i.e., dolphin). To decrypt the nonliteral meaning of this specific expression, we first need to identify the common semantic feature on the basis of which the two different domains are being compared (i.e., swimming ability) (Bühler et al., 2018). Metaphors are usually split between conventional and novel ones on the basis of their familiarity. The same distinction has also been exploited in the field of metaphor processing in ASD. The familiarity of a metaphorical expression is a variable, which has been shown to influence children's metaphor processing skills. According to Bowdle and Gentner (2005), a conventional metaphor is a type of nonliteral expression which, due to its high frequency in everyday oral and written language, functions more as a single word-concept which is stored in the individual's mental lexicon. Processing conventional metaphors relies heavily on fixed vocabulary knowledge (Silvia & Beaty, 2012) and, according to several studies, this particular type of metaphor is processed more easily by individuals with ASD (Giora, 1997; Vulchanova et al., 2012). On the contrary, novel metaphors are innovative nonliteral expressions that are characterized by a low degree of familiarity and whose decoding process requires both sophisticated pragmatic operations (Pouscoulous, 2011) and cognitive ones (Chahboun et al., 2016; Mashal et al., 2013).

It is noteworthy that a considerable number of studies in the domain of metaphor comprehension in ASD focuses primarily on the processing of nominal metaphors. Nominal metaphors establish a nonliteral meaning by positing a relation of equality between two relatively dissimilar entities (metaphors of the type "A is a B", e.g., "My mother is an angel"). On the contrary, the study of predicate metaphor comprehension (e.g., Time is flying) has received little attention, even though such metaphors are frequently encountered in every day oral and written discourse (Steen et al., 2010). In predicate metaphors, a target verb holds a nonliteral meaning, attributing some of the sensory–motor qualities of its literal meaning to the source domain. Since the interpretation of predicate metaphors is assumed to rely on a process of abstraction from the semantic features of the literal verb (Chen et al., 2008), their processing is likely to impose higher cognitive demands as compared with nominal metaphors. However, conventionality is a factor that seems to facilitate their comprehension (Utsumi & Sakamoto, 2011).

The study of the cognitive mechanisms that facilitate metaphor processing has attracted the interest of many researchers from different scientific fields, including psycholinguistics and neurolinguistics (Peng & Khatin-Zadeh, 2023), leading to the configuration of different theoretical approaches which focus on the cognitive processes underlying individuals' comprehension and generation of metaphors (see Holyoak and Stamenković (2018) for a comprehensive review). One of the first and highly influential theories of metaphor processing is the "Conceptual Metaphor Theory" (Lakoff & Johnson, 2003) according to which abstract metaphorical meanings are being perceived through our contextual experience gained by interplays with the social and physical environment. Another fairly popular approach for metaphor processing argues that the ability to interpret metaphorical expressions lies upon individuals' ability to reason analogically (viz., the "Analogy Hypothesis" by Gentner and Clement (1988)), thus, identifying the common properties of different concepts and creating semantic correlations. An evolution of the above theory is the "Career of Metaphor Hypothesis" by Bowdle and Gentner (2005) who argued that, although at an early stage the processing of a metaphor is mainly based on analogical operations, as we become progressively familiar with a metaphorical expression and crystallize its figurative meaning in memory, we tend to perceive it more as a categorical statement. An alternative theoretical framework, known as the "Direct Access View" (Gibbs Jr., 1994) focuses on the interplay between the literal and nonliteral meaning of a metaphorical expression, and argues that the latter can be accessed directly without the need to elaborate the literal meaning beforehand. In contrast, the "Graded Salience Hypothesis" by Giora (1997) suggests that recognizing the literal meaning of a metaphorical expression is a prerequisite for decoding its metaphorical meaning, and that the degree of semantic salience of a metaphor is a key element for its successful processing. Alongside, the "Semantic feature approach" (Nippold, 1998) highlights the importance of identifying the shared semantic qualities of the compared concepts in a metaphorical expression.

It is important to mention that some of the theories described above (e.g., the "Direct Access approach") have also highlighted the crucial role of context in the comprehension of metaphorical meanings. Carston (2012), for instance, argues that supporting context contributes the most to the direct decoding of a metaphorical expression. Moreover, findings of empirical studies with TD children (Stamenković et al., 2020) confirm the contribution of contextual information to the understanding of metaphors. So far, although the field of theoretical approaches to metaphor processing has been fruitful, none of the proposed theoretical models has managed to prevail by offering a comprehensive theoretical framework for metaphor processing which can apply to individuals of both TD and atypical development. Departing from the view of a single metaphor processing account, current research (e.g., Peng & Khatin-Zadeh, 2023) argues for the necessity of adopting broader combinational theoretical models of metaphor processing, which can be verified through different research methods and with experimental groups characterized by different cognitive and behavioral characteristics.

ASD is a neurodevelopmental disorder which consists of a continuum of social and communication difficulties accompanied by restricted interests and stereotypical behaviors (American Psychiatric Publishing, Inc., 2013). Although ASD is characterized by a great interindividual variability in language and cognitive profiles (Peristeri & Andreou, 2024; Schaeffer et al., 2023; Themistocleous et al., 2024), pragmatic abilities appear to be largely compromised across the spectrum. Impairments in the processing of nonliteral language have been regarded for years as a flagship of the pragmatic deficit in ASD (Katsos & Andrés-Roqueta, 2021). More specifically, recent reviews (Kalandadze et al., 2019; Lampri et al., 2023; Morsanyi et al., 2020) document that across studies participants with ASD generally lag behind their TD peers in the comprehension of metaphors. Of note, Kalandadze et al. (2018) claim that metaphors seem to be the most challenging pragmatic phenomenon for individuals with ASD, refuting previous findings (Happé, 1993; MacKay & Shaw, 2004) that pinpointed verbal irony as the most demanding type of nonliteral language in ASD. Nevertheless, in the empirical landscape, there is a well-observed variability in the results across and within studies, showing that there are indeed individuals with ASD who manage to interpret metaphors similarly to their TD peers. For example, several studies (Chouinard & Cummine, 2016; Giora et al., 2012; Hermann et al., 2013; Kasirer & Mashal, 2014) found no statistically significant differences between the performances of TD groups and groups with ASD in metaphor processing. These findings are in contrast with other studies (Borkowska, 2015; Cardillo et al., 2021; Huang et al., 2015; Landa & Goldberg, 2005) in which participants with ASD seemed to struggle to comprehend metaphorical expressions compared with their TD counterparts. The discrepancy across studies may stem from numerous reasons. Namely, methodological differences between the studies' designs (Melogno et al., 2012), variation in task characteristics (Kalandadze et al., 2018), differences in the age ranges of the target groups across studies (Van Herwegen & Rundblad, 2018), and the absence of validated and standardized tools to assess metaphor comprehension (Cardillo et al., 2021) are factors that have possibly led to contradictory findings. Furthermore, the large heterogeneity notices among individual profiles in ASD are beyond doubt a key factor that may account for variation between the studies' results. The variability attested across results in metaphor processing in ASD in relevant studies does not allow us to make strong claims about the presence of a specific or/and a universal impairment in metaphor processing springing from the ASD condition per se.

Regarding research that has investigated the underlying factors that affect metaphor processing in ASD, researchers have focused mainly on individuals' abilities in Theory of Mind (ToM), language and executive functions (EFs). Although previous research (Happé, 1993) has attributed attested difficulties in metaphor processing in ASD to ToM deficits (i.e., difficulty to reason about the mental state of others; Dennett, 1980), researchers over the years have argued that not all individuals with ASD are necessarily impaired in metaphor processing but only those who have poor verbal, and more specifically, low vocabulary skills (Kasirer & Mashal, 2016; Norbury, 2005) and deficits in syntax (Whyte & Nelson, 2015). This hypothesis seems to be also supported by Kissine (2021), who claims that metaphor processing requires pragmatic skills which do not rely upon the individuals' mentalizing skills. Notably, this idea is in contrast with recent findings that have revealed significant correlations between ToM and metaphor comprehension performance in individuals with ASD (Cardillo et al., 2021; Whyte & Nelson, 2015). As prior work in this area is limited, less is known about the exact role of EFs in the processing of metaphors in ASD. Impairments in different aspects of cognitive functions are commonly observed among individuals with ASD (Andreou et al., 2022; Lai et al., 2017). The few studies (Kasirer & Mashal, 2014; Mashal & Kasirer, 2011) that have addressed the relations between EFs and metaphor processing report that cognitive flexibility is a factor that significantly predicts metaphor comprehension in ASD. Although evidence from studies with TD individuals (Chiappe & Chiappe, 2007; Pierce & Chiappe, 2008) suggests that another key EF in metaphor processing is working memory, the role of working memory in the comprehension and production of metaphors in ASD has not been studied yet.

The overall discrepancy in the results on metaphor processing in children with ASD fuels the existing debate surrounding the exact roots of metaphor processing difficulties in ASD. ToM, verbal abilities, and EFs are variables that may contribute in different ways to metaphor processing in ASD (Kalandadze et al., 2018; Lampri et al., 2023; Tzuriel & Groman, 2017); therefore, it is necessary that all three variables are taken into consideration. According to Kasirer and Mashal (2016), the way metaphors are perceived and processed is influenced by multiple external (i.e., nonrelated to an individual's cognitive or language profile) factors such as the type of metaphor (i.e., novel or conventional), exposure to metaphors and task properties (see Kalandadze et al., 2019 for a systematic review on the effect of tasks properties on metaphor processing). Regarding the effect of metaphor familiarity on ASD individuals' metaphor comprehension skills, the results are inconsistent. Some experimental studies (Chahboun et al., 2017; Kasirer & Mashal, 2016) suggest that individuals with ASD understand novel metaphors better than conventional ones. Yet, other studies (Giora, 1997; Gold et al., 2010; Vulchanova et al., 2012; Zheng et al., 2015) provide evidence that conventional metaphors are more easily processed than novel metaphors by participants with ASD. As far as task properties are concerned, one issue that has not received much attention so far is the task's language demands (see Lampri et al., 2023). The great majority of metaphor comprehension studies in ASD have used mostly verbally loaded tasks, in which participants had to read text (Adachi et al., 2004) or/and provide verbal explanations to open questions (Borkowska, 2015; Landa & Goldberg, 2005; Rundblad & Annaz, 2010). As such, the particular tasks seem to require high verbal, metalinguistic, and metacognitive skills, which have often been found to be impaired in groups with ASD (Kwok et al., 2015; Lewis et al., 2007; Melogno et al., 2015; Peristeri et al., 2024). Possible task effects raise the question whether the low performance of participants with ASD in metaphors in the above studies may be interpreted in terms of a deficit specific to figurative language processing, or rather in terms of a broader language deficit within the autistic phenotype. Hence, it is essential that future studies use tasks with low-verbal load in order to be able to disentangle figurative comprehension skills from the individuals' verbal ability. Besides the tasks' verbal load characteristics, many scholars (Kalandadze et al., 2022; Stamenković et al., 2020) argue that tasks with multiple-choice answer formats and visual stimuli place fewer pragmatic demands on participants with ASD, which seems to compensate for the individuals' potentially low language abilities, and thus reliably mirror their metaphor processing skills.

Another gap in the field of metaphor processing in ASD is that few studies so far have examined the ability of individuals with ASD to generate nonliteral meanings (Kasirer & Mashal, 2016; Mashal & Kasirer, 2011). We speculate that a possible reason for this gap is the challenge of designing tasks able to trigger automatic generation of a targeted linguistic phenomenon (Ramos Cabo et al., 2020). Studies so far show that participants with ASD are capable of generating metaphorical structures and, in fact, are occasionally particularly creative in this field (Kasirer & Mashal, 2014). However, due to the paucity of relevant research, we cannot draw firm conclusions about ASD individuals' ability to generate metaphors.

Vicente et al. (2023) point out that the well-known literalism trend of ASD individuals, that is, their tendency to interpret linguistic stimuli literally, including various types of figurative language, lacks empirical basis, as the vast majority of figurative language studies in ASD have focused on the comprehension abilities of individuals with ASD rather than on their bias for literal interpretations. Indeed, only few studies (Chahboun et al., 2017; Kasirer & Mashal, 2014; Olofson et al., 2014) have specifically addressed the literalism trend in metaphor processing in ASD by providing evidence in favor of literal biases. We believe that a fine-grained mapping of the error types to which participants with ASD adhere to in metaphor comprehension and production may contribute to a deeper understanding of the nature of their difficulties in metaphor processing.

Considering all the above-mentioned gaps in relevant research so far, the present study addresses two research questions: (a) Does the ability to comprehend and produce metaphors in children with ASD differs from TD children? and (b) What is the role of age, language skills (i.e., vocabulary) and EFs (i.e., working memory) in the children's ability to understand and produce metaphors? Another focus of the current study is the analysis of error types in metaphor production as a means to further highlight metaphor processing skills in ASD. To the best of our knowledge, this is the first study to address the effects of language and EFs in the metaphor processing abilities of Greek-speaking children with ASD.

METHODS

Participants

The study included in total 49 Greek-speaking children that were split in two groups. The group with ASD comprised 18 (16 males, 2 females) children, and the TD group included 31 age-matched children (17 males, 14 females). The children were recruited from the geographical regions of Peloponnese and Macedonia in northern Greece, and were referred by Centers for Interdisciplinary Evaluation, Counseling and Support (KEDASY) that constitute the official state centers in Greece responsible for the investigation and assessment of educational needs or barriers to learning of pre-school and school-aged students, including students with disabilities or special educational needs, as well as the issuance of a relevant evaluation report. All children received a formal clinical diagnosis of autism from a child psychiatrist or developmental specialist on the basis of the DSM-V, and ICD-10 criteria (American Psychiatric Association, 2013; World Health Organization, 1993). Children with ASD attended mainstream classes in public schools. All the children with ASD were verbally able, that is, they could produce a range of flexible sentence types and grammatical structures, and could also provide information about events out of the immediate context. TD children were recruited via invitation letters distributed to mainstream schools in the geographical regions of Peloponnese and Macedonia in northern Greece.

Baseline tasks

Children's nonverbal IQ was estimated using the Raven's Colored Progressive Matrices Test (RCPM; Raven, 1995). Administering a different intelligence test as a proxy for nonverbal intelligence, for example, the performance IQ scales of the Wechsler Intelligence Scales for Children-Third Edition (WISC-III; Wechsler, 1991; adapted to Greek by Georgas et al., 1997) was deemed impractical mainly due to its long duration (at least in comparison with the duration of the RCPM) and the time-restrictions imposed by the schools that were involved in data collection. All study procedures were approved by the University of Peloponnese Institutional review board (IRB) (IRB protocol number: 18734/19.9.2023).

The study also included two baseline tests that tapped into the children's language and cognitive skills, respectively. More specifically, language screening was carried out through the Expressive Vocabulary Test (Vogindroukas et al., 2009; adaptation from Renfrew & Mitchell, 1997). This instrument assesses expressive vocabulary skills in standard Modern Greek. The test contains 50 pictures depicting commonplace objects of increasing difficulty. The child is awarded one point for each correct picture naming attempt. The maximum possible score is 50. Testing in the expressive vocabulary test was discontinued after five consecutive failures. Besides raw vocabulary scores, we have converted scores into normed vocabulary age equivalents on the basis of the children's chronological ages. We should note that no assessment tool for syntax adapted to Greek is currently available, so autistic children's language profiling was limited to their lexical skills. Though the Peabody Picture Vocabulary Test–Revised (PPVT-R) has been standardized in Greek (Simos et al., 2011), administering the specific task to autistic children would have been challenging mainly because the task is relatively long and requires from the participant to indicate which of four drawings corresponds to a spoken word, which would in turn increase attentional demands for the autistic individuals. We thus assessed the autistic (and TD) children on the standardized Expressive Vocabulary Test (Vogindroukas et al., 2009; adaptation from Renfrew & Mitchell, 1997).

Cognitive screening, on the other hand, included a Backwards Digit Recall Test, which is a computerized measure of verbal working memory from the Automated Working Memory Assessment (AWMA, Alloway, 2007; normed for Greek by Chrysochoou, 2006). In this test, the child is required to recall a sequence of spoken digits in reverse order. Digit sequences were audiotaped by a native speaker of Greek with the distance between the offset of a digit and the onset of the next one to be 1 s. The score is estimated as the number of trials on which the sequence of spoken digits is recalled correctly with a maximum score of 36. Hearing difficulties were established as an exclusionary criterion for the Backwards Digit Recall Test.

Table 1 includes demographic information, as well as the two groups' IQ, expressive vocabulary and backwards digit recall scores.

Due to the fact that the data across the two groups were not normally distributed, group effects were explored through chi-squared tests. The tests showed that the two groups did not differ in either chronological age, X^2 4.05, p 0.06, or in Raven's scores, X^2 1.80, p 0.186. The ASD children's scores on the Raven's Colored Progressive Matrices Test were at the 63th percentile (SD 18.1), indicating an average level of performance (IQ ≥90). The group effect was not significant for expressive vocabulary, X^2 2.60, p 0.113. Though the group with ASD had lower vocabulary age equivalencies than the TD group, the difference between the two groups was not found to be statistically significant, X^2 4.08, p 0.09. On the other hand, there was a significant group effect in backwards digit recall, X^2 6.18, p 0.016, which was due to the fact that the children with ASD scored significantly lower than the TD group.

Measures

Main tasks

Study 1 Metaphor comprehension task

Metaphor selection (pilot study). Based on Chahboun et al., 2016, we conducted a pilot study with 60 children (ages 8—12) which aimed to determine the familiarity of the metaphors in the task. Specifically, after searching books used in Greek elementary schools and relevant dictionaries, we created a questionnaire comprising 30 conventional predicate metaphors. For each metaphorical expression, we asked participants to answer three questions: (a) Have you ever heard this expression? (b) Do you know its meaning? and (c) Do you use this expression? We scored the answers to each question with 1 point for [yes] answers and 0 points for [no] answers, and averaged the total scores from the 3 questions. Responses from three autistic children that were questionable logically (e.g., answering [no] to the first question, but [yes] to the last) were coded as invalid and received 0 points. Following Chahboun et al.'s, 2016 study, we set the 0.80 as a metaphor selection cutoff. The 14 predicate metaphors that were selected as the items to be included in the metaphor comprehension task of the current study received high familiarity ratings (i.e., a mean rating of over 1.6).

Coding schema (main study). Due to the lack of a standardized Greek metaphor comprehension test, we designed a computer-mediated low-verbal sentence-picture matching task based on previous studies in metaphor comprehension in ASD (Cardillo et al., 2021; Chahboun et al., 2016). Fourteen auditory predicate metaphors (4 served as trials of familiarization, and 10 as the main experimental trials) were presented in a short sentence context to aid comprehension (e.g., Turn off the tap. Water is running, see Figure 1). No teaching was allowed in the familiarization trials.

Participants listened to the target sentence (a single repetition of the prompt was allowed) and were then asked to select among four pictures the one that best described the meaning of the target metaphor. The four pictures corresponded to (a) the target (correct) nonliteral interpretation, (b) a literal interpretation, (c) an interpretation that was opposite to the nonliteral meaning, and

TABLE 1 Descriptive statistics (means, SD) of demographic information and children's performances in the Raven's Colored Progressive Matrices Test, expressive vocabulary, and backwards digit recall tests.

Group	Age (years; months)	Standardized raven scores	Expressive vocabulary (max. score: 50)	Normed vocabulary age equivalent (years; months)	Backwards digit recall
ASD	9;6 (*1.9*)	120.3 (*17.8*)	35.8 (*7.9*)	8;9 (*2.3*)	11.2 (*3.5*)*
TD	9;0 (*0.6*)	125.9 (*11.5*)	38.7 (*4.1*)	9;6 (1.4)	14.0 (*4.2*)

Note: Italic values within the parentheses denote the standard deviations of the mean scores.
Abbreviations: ASD, Autism Spectrum Disorder; max.: maximum; TD, typically-developing.
*$p < 0.05$.

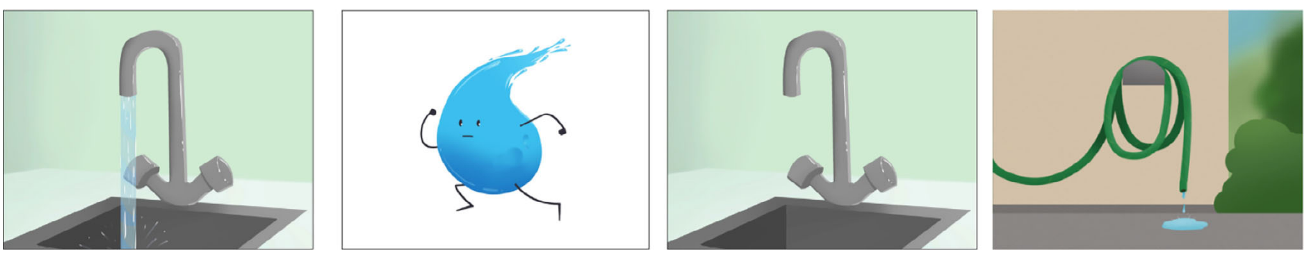

FIGURE 1 Pictures for the metaphor "Turn off the tap. Water is running."

(d) a semantic distractor (specifically, the picture depicted an action which referred to a word from the target sentence but was unrelated to the nonliteral meaning of the expression) (see Figure 1 for an example).

Study 2 Metaphor production task

The metaphor production task of the current study was adapted from the linguistic innovation task of Levorato and Cacciari (2002), and the metaphor generation task of Kasirer and Mashal (2014, 2016).

Concept selection (pilot study). We have first conducted a pilot study with 20 children (ages 8–10) in which children were presented with 20 concepts denoting emotions in the form of a metaphor and were asked to generate a new expression describing the meaning of the target emotion. We first established ratings for each concept (i.e., 1 point for a metaphorical answer and 0 points for a nonmetaphorical answer), and then we averaged the total scores of the items. The 10 concepts that received a rating of over 0.80 were included in the metaphor production task of the current study.

Coding schema (main study). The sentence continuation task of the current study consisted of 10 concepts (i.e., emotions), which were presented to the participants as a metaphor (e.g., Love is a rainbow). After listening to the target sentence, children were asked to repeat it and express the meaning of the target-concept (i.e., love) in a new appropriate way by choosing their own continuation/ending of the sentence (i.e., Love is…………). Importantly, the children were not explicitly asked to create a metaphor but instead they were encouraged to think of something similar to the target concept (i.e., Love). Specifically, phrases such as "What love looks like for you?", or "If you had to make a drawing about love what would you draw?" were used to encourage children to generate new metaphorical expressions. The metaphoricity of the obtained answers were independently evaluated by two adults who were naïve to the purposes of the study. In case of disagreement, a third adult was asked to decide if the generated expression was a metaphor or not (85% interrater agreement). The adults also evaluated the aptness of the generated expressions by classifying the children's responses into the following response categories: (a) target metaphors (e.g., "Love is a sunset") wherein the generated word (i.e., sunset) is a conceptually distant domain from the target concept (i.e., Love) but holds common semantic features, (b) nontarget metaphors (e.g. "Love is pencil") where the new expression is metaphorical but does not describe the meaning of the target emotion (i.e. Love) or/and is a domain that is not conceptually distant from the target emotion (e.g., Love is joy), (c) literal answers (e.g., "Anger is irritation") where the generated expressions constitute definitions or synonyms of the target concept, and, finally, (d) inappropriate answers (e.g., Love is ok) that are neither metaphorical nor literal, and fail to describe the meaning of the target concept.

RESULTS

We ran a linear mixed-effects model, with Group (ASD, TD), Raven's scores (as a measure for intelligence), vocabulary, backwards digit recall scores (as a measure for working memory) and age as the predictors, and metaphor production and comprehension scores as the dependent variables. The model included random slopes for participants. Due to the fact that error rates were not normally distributed across the two groups, differences between children with ASD and TD children in error rates in metaphor production were explored though chi-squared tests.

Table 2 below presents the groups' mean accuracy performance scores in the metaphor production and comprehension task. Table 2 also includes the groups' mean error rates per error-type (i.e., literal, nontarget, inappropriate and no response) in the metaphor production task.

Table 3 below illustrates the output of the linear mixed-effects model (p values significant beyond the 0.05 cutoff are in bold). The model fitted to the metaphor production and comprehension data of the study found significant group effects for both skills; specifically, TD children scored higher than their peers with ASD in both metaphor production and comprehension. Vocabulary

TABLE 2 Descriptive statistics (means, SD) of groups' mean metaphor production and comprehension accuracy, and mean erroneous performances per error-type (literal, nontarget, inappropriate, no-response) in the metaphor production task.

Group	Metaphor production accuracy (max. score 10)	Error-types (metaphor production)				Metaphor comprehension accuracy (max. score: 10)
		Literal	Nontarget	Inappropriate	No-response	
ASD	3.2 (*2.0*)	2.7 (*1.9*)	1.3 (*1.7*)	1.9 (*1.8*)**	0.8 (*1.6*)*	7.8 (*1.9*)
TD	6.0 (*2.3*)	2.2 (*2.0*)	0.8 (*1.2*)	0.8 (*0.9*)	0.2 (*0.4*)	9.3 (*0.8*)

Note: Italic values within the parentheses denote the standard deviations of the mean scores.

Abbreviations: ASD, Autism Spectrum Disorder; max.: maximum; TD, typically-developing.

*$p < 0.05$.

**$p < 0.01$.

TABLE 3 Summary of the mixed effects model for metaphor production and comprehension scores.

	Metaphor production				Metaphor comprehension			
Predictors	**Coeff.**	**SE**	***z***	***p***	**Coeff.**	**SE**	***z***	***p***
Group	4.46	0.35	12.48	0.004**	8.56	0.19	42.99	<0.001***
Raven	2.23	2.22	1.00	0.323	14.89	21.94	0.67	0.513
Vocabulary	0.20	0.06	3.19	0.05*	0.68	0.19	3.56	0.031*
Group × vocabulary	3.19	0.10	31.47	0.003**	0.72	0.19	3.65	<0.001***
Backwards digit	1.33	1.74	0.76	0.455	7.72	0.99	7.78	0.05*
Group × backwards digit	0.18	0.06	3.05	0.06	6.90	0.77	8.89	<0.001***
Age	0.24	0.08	3.11	0.003**	0.17	0.20	0.83	0.426
Group × age	7.56	0.43	17.52	<0.001***	0.20	0.39	0.51	0.996

Abbreviations: Coeff., coefficient; SE, standard error.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

significantly predicted both metaphor production and comprehension, while backwards digit recall significantly predicted metaphor comprehension. There were significant two-way interactions between group and vocabulary in both metaphor production and comprehension, since vocabulary had a significant effect on metaphor production, $t(1, 13)$ 18.00, $p < 0.001$, and comprehension, $t(1, 16)$ 18.72, $p < 0.001$, only for the children with ASD (TD children: $t(1, 30)$ 3.16, p 0.09 for metaphor production, and $t(1, 30)$ 0.96, p 0.924 for metaphor comprehension). There was also a significant two-way interaction between group and backwards digit recall in metaphor comprehension, which stemmed from the fact that backwards digit predicted metaphor comprehension scores for the children with ASD, $t(1, 13)$ 4.55, p 0.041, but not TD children, $t(1, 30)$ 1.86, p 0.182. Finally, there was a significant two-way interaction between group and age in metaphor production, which stemmed from the fact that metaphor production accuracy scores significantly increased with age for the TD children, $t(1, 30)$ 14.53, $p < 0.001$, but not the children with ASD, $t(1, 13)$ 0.12, p 0.735.

Regarding error-types in the metaphor production task, the children with ASD tended to produce significantly more inappropriate responses, X^2 8.29, p 0.006, and more no-responses, X^2 4.76, p 0.034, than the TD group. The two groups did not differ in either literal, X^2 0.54, p 0.462, or nontarget responses, X^2 1.42, p 0.24 (see Table 2).

DISCUSSION

The current study aimed at investigating metaphor comprehension and production in school-aged children with ASD and age-matched TD children, while also exploring possible links between metaphor processing and children's language and EF skills. Crucially, the study has employed a low-verbal task to assess children's metaphor comprehension skills, thus, keeping language demands to the minimum. The overall results show that metaphor production and comprehension were challenging for children on the spectrum, and that both were significantly affected by the children's lexical skills. Metaphor comprehension was also found to critically rely on the children's working memory skills.

More specifically, the study's first research question was to investigate if children with ASD differ from their TD peers in their ability to comprehend and produce metaphors. The results revealed that the children with ASD fell behind TD controls in the comprehension of conventional predicate metaphors. This finding is consistent with previous studies (Cardillo et al., 2021; Chahboun et al., 2016) that utilized low-verbal tasks to assess metaphor comprehension in ASD. The same pattern was also found in the metaphor production task, where TD children again outperformed participants with ASD. Crucially, the fact that there was no significant discrepancy in either the expressive vocabulary scores or the vocabulary age equivalencies between the two groups implies that performance differences in metaphor production and comprehension were not confounded by the ASD children's language abilities. We should note, however, that there was a 9-month discrepancy between the chronological and vocabulary ages for the group with ASD, with the mean chronological age being greater than the vocabulary age, while the reverse pattern was observed for the TD group, that is, the mean vocabulary age of TD children was greater than chronological age by 6 months. Though this discrepancy may suggest a language delay for the group with ASD, the low verbal nature of the tasks discards the possibility that the ASD children's performance was compromised by vocabulary weaknesses. Notably, the low verbal status of the tasks in the current study may also strengthen their utility function with bilingual child populations with ASD, whose performance in various socio-pragmatic tasks has been shown to be compromised by the verbal load of the tasks used (Andreou et al., 2020; Andrés-Roqueta & Katsos, 2020).

The current results in metaphor production seem to contradict the findings of studies that used a similar metaphor generation task and found either no significant differences between groups with and without ASD (Kasirer & Mashal, 2016), or a unique verbal creativity in individuals with ASD who performed better than their TD peers (Kasirer et al., 2020). Another interesting finding in the metaphor production task pertains to the errors committed by the group with ASD. Specifically, children with ASD tended to produce significantly more inappropriate responses and no-responses compared with the TD group. However, the two groups did not differ in either literal or nontarget responses. It is essential to interpret this pattern by considering potential differences in the language skills of the two groups. TD children typically demonstrate stronger language abilities compared with many children with ASD, including skills in vocabulary and syntax (Peristeri et al., 2017, 2020). In contrast, language impairments commonly observed in children with ASD may hinder their ability to generate suitable metaphorical expressions, thus, leading to a higher incidence of errors. However, it is important to acknowledge the significant heterogeneity within the autism spectrum. While some individuals with ASD exhibit language abilities that are on par with or even exceed those of TD peers, others may experience challenges in language comprehension and expression. The variability in linguistic profiles within the spectrum can impact performance on metaphor tasks, with different individuals demonstrating unique strengths and weaknesses in figurative language processing.

The second research question aimed to explore the potential influence of age, language proficiency (i.e., vocabulary), and EFs (i.e., working memory) on children's metaphorical comprehension and production abilities. According to the results, there was no significant correlation observed between age and metaphor comprehension and production scores of the children with ASD. This finding is consistent with previous studies arguing that chronological age is neither a predictor of conventional metaphor comprehension in ASD (Gernsbacher & Pripas-Kapit, 2012; Kalandadze et al., 2018; Rundblad & Annaz, 2010) nor a predictor of metaphor generation (Kasirer & Mashal, 2016). Conversely, chronological age was found to be significantly correlated with metaphor production scores among TD children, which is in line with findings from previous studies (Carriedo et al., 2016; Deckert et al., 2019). The abovementioned studies mention that as children grow, they experience improvement in linguistic abilities, cognitive flexibility, and abstract thinking, all of which are essential for metaphor generation. These developmental changes likely contribute to the observed age-related differences in metaphorical proficiency, even within a relatively homogenous group of TD children as in our case. Additionally, exposure to diverse language contexts and increased neural maturation may further enhance metaphorical skills with age.

The study has also revealed that expressive vocabulary (i.e., language skills) correlated with both metaphor comprehension and production performance in the children with ASD (Kalandadze et al., 2022; Morsanyi et al., 2022). However, that was not the case for the TD children. A possible explanation may be that while expressive vocabulary possibly contributes to metaphor comprehension and production in some TD children, it may not be as consistently predictive across the entire TD population. Other cognitive factors, such as cognitive flexibility, abstract thinking, and exposure to various language experiences, may play a more prominent role in metaphor processing among TD children. Finally, verbal working memory capacity measured though the digit backwards task contributed to the metaphor comprehension performance of the group with ASD only (Morsanyi et al., 2022). The few studies (Kasirer & Mashal, 2014; Mashal & Kasirer, 2011) that have addressed the relations between EFs and metaphor processing in ASD highlight cognitive flexibility as the most important predictor of metaphor comprehension in the specific population. However, EFs encompassing cognitive flexibility, planning, and inhibition exhibit variations between individuals with ASD and their TD counterparts (Chaku et al., 2022; Cordova et al., 2020). It is conceivable that TD children employ alternative EFs or cognitive processes that may not be directly linked to working memory for metaphor comprehension. Alternatively, TD children may rely more heavily on contextual verbal or nonverbal cues when comprehending metaphors compared with children with ASD. These alternative strategies could alleviate the necessity for using extensive working memory resources during metaphor comprehension in TD children.

LIMITATIONS AND FUTURE DIRECTIONS

Some limitations of the study need to be considered. First, the current study has only tested children's verbal working memory skills, so follow up studies should consider expanding the measures of EFs to also include cognitive flexibility and inhibition. Additionally, the incorporation of a task assessing ToM is imperative, since mentalizing skills may have considerable impact on metaphor processing in ASD (Kalandadze et al., 2018; Lampri et al., 2023; Tzuriel & Groman, 2017). Also, since the current study only included children with ASD and no intellectual impairment, it would be interesting to include children with low cognitive skills, and investigate the effect of cognitive capacity on children's metaphor processing abilities. Furthermore, another limitation of this study is that the two groups were matched on age rather than nonverbal IQ. Matching children on nonverbal IQ would allow a deeper understanding of the factors influencing autistic children's metaphor comprehension and production, and future work should replicate the current design with nonverbal IQ-matched autistic and TD groups. The fact that female participants were underrepresented in the group with ASD that have participated in the current study (16 males, 2 females) does not allow us to explore gender differences in metaphor processing in ASD. Similarly, the sample of the children with ASD spanned a wide age range (7–12 years), which does not allow us to identify possible sensitive time windows in children's metaphor production and comprehension skills. Finally, since metaphorically used words and expressions may vary considerably across different languages, it would be interesting to investigate the effect of cross-language differences on the metaphor comprehension skills of children with ASD and different language backgrounds.

AUTHOR CONTRIBUTIONS

Conceptualization: M.A. *Methodology*: M.A., E.P., T.M., and S.L. *Software*: M.A., E.P. *Formal analysis*: M.A. and E.P. *Data curation*: M.A. and E.P. *Writing— original draft preparation*: M.A., E.P., and S. L. *Writing— review and editing*: S.L., E.P., T.M., and M. A. *Supervision*: M.A. *Project administration*: M.A. All authors have read and agreed to the published version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or nonfinancial interest in the subject matter or materials discussed in this manuscript. The study was approved by the Institutional Review Board (or Ethics Committee) of the University of Peloponnese (protocol-code 18734/19-09-2023). The study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki.

INFORMED CONSENT

Before data collection, the parents of all participants provided informed written consent for participation in the study.

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REFERENCES

Adachi, T., Koeda, T., Hirabayashi, S., Maeoka, Y., Shiota, M., Charles Wright, E., & Wada, A. (2004). The metaphor and sarcasm scenario test: A new instrument to help differentiate high functioning pervasive developmental disorder from attention deficit/hyperactivity disorder. *Brain and Development*, *26*(5), 301–306. https://doi.org/10.1016/S0387-7604(03)00170-0

American Psychiatric Publishing, Inc. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5™* (5th ed., p. 947). American Psychiatric Association Publishing. https://doi.org/10.1176/appi.books.9780890425596

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). American Psychiatric Association. https://doi.org/10.1176/appi.books.9780890425596

Alloway, T. P. (2007). *Automated Working Memory Assessment*. Pearson Assessment.

Andreou, M., Konstantopoulos, K., & Peristeri, E. (2022). Cognitive flexibility in autism: Evidence from young autistic children. *Autism Research*, *15*, 2296–2309.

Andreou, M., Tsimpli, I. M., Durrleman, S., & Peristeri, E. (2020). Theory of mind, executive functions, and syntax in bilingual children with autism spectrum disorder. *Language*, *5*(4), 67. https://doi.org/10.3390/languages5040067

Andrés-Roqueta, C., & Katsos, N. (2020). A distinction between linguistic and social pragmatics helps the precise characterization of pragmatic challenges in children with autism spectrum disorders and developmental language disorder. *Journal of Speech, Language, and Hearing Research*, *63*(5), 1494–1508. https://doi.org/10.1044/2020_JSLHR-19-00263

Borkowska, A. (2015). Language and communicative functions as well as verbal fluency in children with high-functioning autism. *Journal of Intellectual Disability Diagnosis and Treatment*, *3*, 147–153. https://doi.org/10.6000/2292-2598.2015.03.03.4

Bowdle, B. F., & Gentner, D. (2005). The career of metaphor. *Psychological Review*, *112*(1), 193–216. https://doi.org/10.1037/0033-295X.112.1.193

Bühler, D., Perovic, A., & Pouscoulous, N. (2018). Comprehension of novel metaphor in young children with developmental language disorder. *Autism & Developmental Language Impairments*, *3*, 2396941518817229. https://doi.org/10.1177/2396941518817229

Cardillo, R., Mammarella, I. C., Demurie, E., Giofrè, D., & Roeyers, H. (2021). Pragmatic language in children and adolescents with autism spectrum disorder: Do theory of mind and executive functions have a mediating role? *Autism Research*, *14*(5), 932–945. https://doi.org/10.1002/aur.2423

Carriedo, N., Corral, A., Montoro, P. R., Herrero, L., Ballestrino, P., & Sebastián, I. (2016). The development of metaphor comprehension and its relationship with relational verbal reasoning and executive function. *PLoS One*, *11*(3), e0150289. https://doi.org/10.1371/journal.pone.0150289

Carston, R. (2012). Metaphor and the literal/nonliteral distinction. In K. Allan & K. Jaszczolt (Eds.), *Cambridge handbook of pragmatics* (pp. 469–492). Cambridge University Press.

Chahboun, S., Vulchanov, V., Saldaña, D., Eshuis, H., & Vulchanova, M. (2016). Can you play with fire and not hurt yourself? A comparative study in figurative language comprehension between individuals with and without autism spectrum disorder. *PLoS One*, *11*(12), e0168571. https://doi.org/10.1371/journal.pone.0168571

Chahboun, S., Vulchanov, V., Saldaña, D., Eshuis, H., & Vulchanova, M. (2017). Can you tell it by the prime? A study of metaphorical priming in high-functioning autism in comparison with matched controls: Metaphorical priming in high-functioning autism and matched controls. *International Journal of Language & Communication Disorders*, *52*(6), 766–785. https://doi.org/10.1111/1460-6984.12314

Chaku, N., Barry, K., Fowle, J., & Hoyt, L. T. (2022). Understanding patterns of heterogeneity in executive functioning during adolescence: Evidence from population-level data. *Developmental Science*, *25*(6), e13256. https://doi.org/10.1111/desc.13256

Chen, E., Widick, P., & Chatterjee, A. (2008). Functional–anatomical organization of predicate metaphor processing. *Brain and Language*, *107*(3), 194–202. https://doi.org/10.1016/j.bandl.2008.06.007

Chiappe, D. L., & Chiappe, P. (2007). The role of working memory in metaphor production and comprehension. *Journal of Memory and Language*, *56*(2), 172–188. https://doi.org/10.1016/j.jml.2006.11.006

Chouinard, B., & Cummine, J. (2016). All the world's a stage: Evaluation of two stages of metaphor comprehension in people with autism spectrum disorder. *Research in Autism Spectrum Disorders*, *23*, 107–121. https://doi.org/10.1016/j.rasd.2015.12.008

Chrysochoou, E. (2006). *Working memory contributions to children's listening comprehension in the preschool and elementary school years. PhD Thesis*. Department of Early Childhood Education, Aristotle University of Thessaloniki.

Colston, H. (2023). The roots of metaphor: The essence of thought. *Frontiers in Psychology*, *14*. https://doi.org/10.3389/fpsyg.2023.1197346

Cordova, M., Shada, K., Demeter, D. V., Doyle, O., Miranda-Dominguez, O., Perrone, A., Schifsky, E., Graham, A., Fombonne, E., Langhorst, B., Nigg, J., Fair, D. A., & Feczko, E. (2020). Heterogeneity of executive function revealed by a functional random forest approach across ADHD and ASD. *NeuroImage: Clinical*, *26*, 102245. https://doi.org/10.1016/j.nicl.2020.102245

Deckert, M., Schmoeger, M., Schaunig-Busch, I., & Willinger, U. (2019). Metaphor processing in middle childhood and at the transition to early adolescence: The role of chronological age, mental age, and verbal intelligence. *Journal of Child Language*, *46*(2), 334–367. https://doi.org/10.1017/S0305000918000491

Dennett, D. (1980). The milk of human intentionality. *Behavioral and Brain Sciences*, *3*(3), 428–430. https://doi.org/10.1017/S0140525X0000580X

Dietrich, A. (2004). The cognitive neuroscience of creativity. *Psychonomic Bulletin & Review*, *11*(6), 1011–1026. https://doi.org/10.3758/bf03196731

Falkum, I. L., Recasens, M., & Clark, E. V. (2017). "The moustache sits down first": On the acquisition of metonymy. *Journal of Child Language*, *44*(1), 87–119. https://doi.org/10.1017/S0305000915000720

Gentner, D., & Clement, C. (1988). Evidence for relational selectivity in the interpretation of analogy and metaphor. In *The psychology of learning and motivation: Advances in research and theory* (Vol. 22, pp. 307–358). Academic Press. https://doi.org/10.1016/S0079-7421(08)60044-4

Georgas, J., Paraskevopoulos, I. N., Besevegis, E., Giannitsas, N., & Mylonas, K. (1997). *Ελληνικό WISC-III: Wechsler κλίμακες νοημοσύνης για παιδιά [Greek WISC-III: Wechsler intelligence scale for children]*. Ellinika Grammata.

Gernsbacher, M. A., & Pripas-Kapit, S. R. (2012). Who's missing the point? A commentary on claims that autistic persons have a specific deficit in figurative language comprehension. *Metaphor and Symbol*, *27*(1), 93–105. https://doi.org/10.1080/10926488.2012.656255

Gibbs, R. W., Jr. (1994). *The poetics of mind: Figurative thought, language, and understanding* (ix, 527). Cambridge University Press.

Giora, R. (1997). Understanding Figurative and Literal Language: The Graded Salience Hypothesis. *Cognitive Linguistics*, *8*(3), 183–206. https://doi.org/10.1515/cogl.1997.8.3.183

Giora, R., Gazal, O., Goldstein, I., Fein, O., & Stringaris, A. (2012). Salience and context: Interpretation of metaphorical and literal language by young adults diagnosed with Asperger's syndrome. *Metaphor and Symbol*, *27*(1), 22–54. https://doi.org/10.1080/10926488.2012.638823

Glucksberg, S. (2001). *Understanding figurative language: From metaphors to idioms* (vii, 134). Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195111095.001.0001

Gold, R., Faust, M., & Goldstein, A. (2010). Semantic integration during metaphor comprehension in Asperger syndrome. *Brain and Language*, *113*(3), 124–134. https://doi.org/10.1016/j.bandl.2010.03.002

Happé, F. G. (1993). Communicative competence and theory of mind in autism: A test of relevance theory. *Cognition*, *48*(2), 101–119. https://doi.org/10.1016/0010-0277(93)90026-r

Hermann, I., Haser, V., van Elst, L. T., Ebert, D., Müller-Feldmeth, D., Riedel, A., & Konieczny, L. (2013). Automatic metaphor processing in adults with Asperger syndrome: A metaphor interference effect task. *European Archives of Psychiatry and Clinical Neuroscience*, *263*(Suppl 2), S177–S187. https://doi.org/10.1007/s00406-013-0453-9

Holyoak, K. J., & Stamenković, D. (2018). Metaphor comprehension: A critical review of theories and evidence. *Psychological Bulletin*, *144*(6), 641–671. https://doi.org/10.1037/bul0000145

Huang, S.-F., Oi, M., & Taguchi, A. (2015). Comprehension of figurative language in Taiwanese children with autism: The role of theory of mind and receptive vocabulary. *Clinical Linguistics & Phonetics*, *29*(8–10), 764–775. https://doi.org/10.3109/02699206.2015.1027833

Ifantidou, E., & Piata, A. (2021). Metaphor and mental shortcuts: The role of non-propositional effects. *Pragmatics & Cognition*, *28*(2), 299–320. https://doi.org/10.1075/pc.21009.ifa

Kalandadze, T., Bambini, V., & Næss, K.-A. B. (2019). A systematic review and meta-analysis of studies on metaphor comprehension in individuals with autism spectrum disorder: Do task properties matter? *Applied PsychoLinguistics*, *40*(6), 1421–1454. https://doi.org/10.1017/S0142716419000328

Kalandadze, T., Braeken, J., Brynskov, C., & Næss, K.-A. B. (2022). Metaphor comprehension in individuals with autism spectrum disorder: Core language skills matter. *Journal of Autism and Developmental Disorders*, *52*(1), 316–326. https://doi.org/10.1007/s10803-021-04922-z

Kalandadze, T., Norbury, C., Nærland, T., & Næss, K.-A. B. (2018). Figurative language comprehension in individuals with autism spectrum disorder: A meta-analytic review. *Autism*, *22*(2), 99–117. https://doi.org/10.1177/1362361316668652

Kasirer, A., Adi-Japha, E., & Mashal, N. (2020). Verbal and figural creativity in children with autism Spectrum disorder and typical development. *Frontiers in Psychology*, *11*, 559238. https://doi.org/10.3389/fpsyg.2020.559238

Kasirer, A., & Mashal, N. (2014). Verbal creativity in autism: Comprehension and generation of metaphoric language in high-functioning autism spectrum disorder and typical development. *Frontiers in Human Neuroscience*, *8*, 615. https://doi.org/10.3389/fnhum.2014.00615

Kasirer, A., & Mashal, N. (2016). Comprehension and generation of metaphors by children with autism spectrum disorder. *Research in Autism Spectrum Disorders*, *32*, 53–63. https://doi.org/10.1016/j.rasd.2016.08.003

Katsos, N., & Andrés-Roqueta, C. (2021). Where next for pragmatics and mind reading? A situation-based view (response to Kissine). *Language*, *97*(3), e184–e197. https://muse.jhu.edu/pub/24/article/806337

Katz, A. N. (2016). Psycholinguistic approaches to metaphor acquisition and use. In *The Routledge handbook of metaphor and language*. Routledge.

Kissine, M. (2021). Autism, constructionism, and nativism. *Language*, *97*(3), e139–e160. https://muse.jhu.edu/pub/24/article/806356

Kwok, E. Y. L., Brown, H. M., Smyth, R. E., & Oram Cardy, J. (2015). Meta-analysis of receptive and expressive language skills in autism spectrum disorder. *Research in Autism Spectrum Disorders*, *9*, 202–222. https://doi.org/10.1016/j.rasd.2014.10.008

Lai, C. L. E., Lau, Z., Lui, S. S. Y., Lok, E., Tam, V., Chan, Q., Cheng, K. M., Lam, S. M., & Cheung, E. F. C. (2017). Meta-analysis of neuropsychological measures of executive functioning in children and adolescents with high-functioning autism spectrum disorder. *Autism Research*, *10*(5), 911–939. https://doi.org/10.1002/aur.1723

Lakoff, G., & Johnson, M. (2003). *Metaphors we live by*. University of Chicago Press. https://doi.org/10.7208/chicago/9780226470993.001.0001

Lampri, S., Peristeri, E., Marinis, T., & Andreou, M. (2023). Figurative language processing in autism spectrum disorders: A review. *Autism Research*, *17*, 674–689. https://doi.org/10.1002/aur.3069

Landa, R. J., & Goldberg, M. C. (2005). Language, social, and executive functions in high functioning autism: A continuum of performance. *Journal of Autism and Developmental Disorders*, *35*(5), 557–573. https://doi.org/10.1007/s10803-005-0001-1

Levorato, M. C., & Cacciari, C. (2002). The creation of new figurative expressions: Psycholinguistic evidence in Italian children, adolescents and adults. *Journal of Child Language*, *29*(1), 127–150. https://doi.org/10.1017/S0305000901004950

Lewis, F. M., Murdoch, B. E., & Woodyatt, G. C. (2007). Communicative competence and metalinguistic ability: Performance by children and adults with autism spectrum disorder. *Journal of Autism and Developmental Disorders*, *37*(8), 1525–1538. https://doi.org/10.1007/s10803-006-0265-0

MacKay, G., & Shaw, A. (2004). A comparative study of figurative language in children with autistic spectrum disorders. *Child Language Teaching and Therapy*, *20*(1), 13–32. https://doi.org/10.1191/0265659004ct261oa

Mashal, N., & Kasirer, A. (2011). Thinking maps enhance metaphoric competence in children with autism and learning disabilities. *Research in Developmental Disabilities*, *32*(6), 2045–2054. https://doi.org/10.1016/j.ridd.2011.08.012

Mashal, N., Vishne, T., Laor, N., & Titone, D. (2013). Enhanced left frontal involvement during novel metaphor comprehension in schizophrenia: Evidence from functional neuroimaging. *Brain and Language*, *124*(1), 66–74. https://doi.org/10.1016/j.bandl.2012.11.012

Melogno, S., Pinto, M. A., & Levi, G. (2012). Metaphor and metonymy in ASD children: A critical review from a developmental perspective. *Research in Autism Spectrum Disorders*, *6*(4), 1289–1296. https://doi.org/10.1016/j.rasd.2012.04.004

Melogno, S., Pinto, M. A., & Levi, G. (2015). Profile of the linguistic and metalinguistic abilities of a gifted child with autism spectrum disorder: A case study. *Child Language Teaching and Therapy*, *31*(1), 113–126. https://doi.org/10.1177/0265659014530414

Morsanyi, K., Hamilton, J., Stamenković, D., & Holyoak, K. J. (2022). Linking metaphor comprehension with analogical reasoning: Evidence from typical development and autism spectrum disorder. *British Journal of Psychology*, *113*(2), 479–495. https://doi.org/10.1111/bjop.12542

Morsanyi, K., Stamenković, D., & Holyoak, K. J. (2020). Metaphor processing in autism: A systematic review and meta-analysis. *Developmental Review*, *57*, 100925. https://doi.org/10.1016/j.dr.2020.100925

Nippold, M. A. (1998). *Later language development: The school-age and adolescent years* (2nd ed.). Pro-Ed, 8700 Shoal Creek Blvd.

Norbury, C. F. (2005). The relationship between theory of mind and metaphor: Evidence from children with language impairment and autistic spectrum disorder. *British Journal of Developmental Psychology*, *23*, 383–399. https://doi.org/10.1348/026151005X26732

Olofson, E. L., Casey, D., Oluyedun, O. A., Van Herwegen, J., Becerra, A., & Rundblad, G. (2014). Youth with autism spectrum disorder comprehend lexicalized and novel primary conceptual metaphors. *Journal of Autism and Developmental Disorders*, *44*(10), 2568–2583. https://doi.org/10.1007/s10803-014-2129-3

Peng, Z., & Khatin-Zadeh, O. (2023). Research on metaphor processing during the past five decades: A bibliometric analysis. *Humanities and Social Sciences Communications*, *10*(1), 1–13. https://doi.org/10.1057/s41599-023-02465-5

Peristeri, E., & Andreou, M. (2024). Intellectual development in young children with autism spectrum disorders: A longitudinal study. *Autism Research*, *17*, 543–554. https://doi.org/10.1002/aur.3089

Peristeri, E., Andreou, M., & Tsimpli, I. M. (2017). Syntactic and story structure complexity in the narratives of high- and low-language ability children with autism spectrum disorder. *Frontiers in Psychology*, *8*, 2027. https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2017.02027

Peristeri, E., Baldimtsi, E., Andreou, M., & Tsimpli, I. M. (2020). The impact of bilingualism on the narrative ability and the executive functions of children with autism spectrum disorders. *Journal of Communication Disorders*, *85*, 105999. https://doi.org/10.1016/j.jcomdis.2020.105999

Peristeri, E., Frantzidis, C. A., & Andreou, M. (2024). Reading comprehension differences between children with Autism Spectrum Disorder with low cognitive abilities and children with Autism Spectrum Disorder and intact cognitive skills: The roles of decoding, fluency and morphosyntax. *Frontiers in Psychology*, *15*, 1357590. https://doi.org/10.3389/fpsyg.2024.1357590

Pierce, R. S., & Chiappe, D. L. (2008). The roles of aptness, conventionality, and working memory in the production of metaphors and similes. *Metaphor and Symbol*, *24*(1), 1–19. https://doi.org/10.1080/10926480802568422

Pouscoulous, N. (2011). Metaphor: For adults only? *Belgian Journal of Linguistics*, *25*(1), 51–79. https://doi.org/10.1075/bjl.25.04pou

Ramos Cabo, S., Vulchanov, V., & Vulchanova, M. (2020). Different ways of making a point: A study of gestural communication in typical and atypical early development. *Autism Research*, *14*, 984–996. https://doi.org/10.1002/aur.2438

Renfrew, C. E., & Mitchell, P. (1997). *Word finding vocabulary test*. Taylor & Francis Group. https://books.google.gr/books?id=VdDhAQAACAAJ

Raven, J. C. (1995). *Coloured progressive matrices(CPM)*. Oxford, UK: Oxford Psychologists Press.

Rundblad, G., & Annaz, D. (2010). The atypical development of metaphor and metonymy comprehension in children with autism. *Autism*, *14*(1), 29–46. https://doi.org/10.1177/1362361309340667

Schaeffer, J., El-Raziq, M., Castroviejo, E., Durrleman, S., Ferré, S., Grama, I., Hendriks, P., Kissine, M., Manenti, M., Marinis, T., Meir, N., Novogrodsky, R., Perovic, A., Panzeri, F., Silleresi, S., Sukenik, N., Vicente, A., Zebib, R., Prévost, P., & Tuller, L.

(2023). Language in autism: Domains, profiles and co-occurring conditions. *Journal of Neural Transmission*, *130*, 433–457. https://doi.org/10.1007/s00702-023-02592-y

Silvia, P. J., & Beaty, R. E. (2012). Making creative metaphors: The importance of fluid intelligence for creative thought. *Intelligence*, *40*(4), 343–351. https://doi.org/10.1016/j.intell.2012.02.005

Simos, P. G., Sideridis, G. D., Protopapas, A., & Mouzaki, A. (2011). Psychometric evaluation of a receptive vocabulary test for Greek elementary students. *Assessment for Effective Intervention*, *37*(1), 34–49. https://doi.org/10.1177/1534508411413254

Stamenković, D., Ichien, N., & Holyoak, K. J. (2020). Individual differences in comprehension of contextualized metaphors. *Metaphor and Symbol*, *35*(4), 285–301. https://doi.org/10.1080/10926488.2020.1821203

Steen, G. J., Dorst, A. G., Herrmann, J. B., Kaal, A. A., Krennmayr, T., & Pasma, T. (2010). *A method for linguistic metaphor identification. From MIP to MIPVU*. John Benjamins.

Swineford, L. B., Thurm, A., Baird, G., Wetherby, A. M., & Swedo, S. (2014). Social (pragmatic) communication disorder: A research review of this new DSM-5 diagnostic category. *Journal of Neurodevelopmental Disorders*, *6*(1), 41. https://doi.org/10.1186/1866-1955-6-41

Themistocleous, C., Andreou, M., & Peristeri, E. (2024). Autism Detection in Children: Integrating Machine Learning and Natural Language Processing in Narrative Analysis. *Behavioral Sciences*, *14*(6), 459. https://doi.org/10.3390/bs14060459

Tzuriel, D., & Groman, T. (2017). Dynamic assessment of figurative language of children in the autistic spectrum: The relation to some cognitive and language aspects. *Journal of Cognitive Education and Psychology*, *16*(1), 38–63. https://doi.org/10.1891/1945-8959.16.1.38

Utsumi, A., & Sakamoto, M. (2011). Indirect categorization as a process of predicative metaphor comprehension. *Metaphor and Symbol*, *26*(4), 299–313. https://doi.org/10.1080/10926488.2011.609120

Van Herwegen, J., & Rundblad, G. (2018). A cross-sectional and longitudinal study of novel metaphor and metonymy comprehension in children, adolescents, and adults with autism spectrum disorder. *Frontiers in Psychology*, *9*, 945. https://doi.org/10.3389/fpsyg.2018.00945

Vicente, A., Michel, C., & Petrolini, V. (2023). Literalism in autistic people: A predictive processing proposal. *Review of Philosophy and Psychology*. https://doi.org/10.1007/s13164-023-00704-x

Vogindroukas, I., Protopapas, A., & Sideridis, G. (2009). *Experiment on the Expressive vocabulary (Greek version of Renfrew word finding vocabulary test)*. Glafki.

Vulchanova, M., Talcott, J. B., Vulchanov, V., Stankova, M., & Eshuis, H. (2012). Morphology in autism spectrum disorders: Local processing bias and language. *Cognitive Neuropsychology*, *29*(7–8), 584–600. https://doi.org/10.1080/02643294.2012.762350

Wechsler, D. (1991). *The Wechsler intelligence scale for children—Third edition*. The Psychological Corporation.

World Health Organization (WHO). (1993). *The ICD-10 classisication of mental and behavioural disorders*. World Health Organization.

Whyte, E. M., & Nelson, K. E. (2015). Trajectories of pragmatic and nonliteral language development in children with autism spectrum disorders. *Journal of Communication Disorders*, *54*, 2–14. https://doi.org/10.1016/j.jcomdis.2015.01.001

Zheng, Q., Jia, Z., & Liang, D. (2015). Metaphor and metonymy comprehension in Chinese-speaking children with high-functioning autism. *Research in Autism Spectrum Disorders*, *10*, 51–58. https://doi.org/10.1016/j.rasd.2014.11.007

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