Comprehension of Verbal and Visual Metaphors among Individuals with Intellectual Disability with and without Down Syndrome

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Abstract: Studies examining the visual and verbal metaphorical comprehension of individuals with non-specific intellectual disability (NSID) are remarkably scarce; to date only one case study examined comprehension of metaphors in an individual with Down syndrome (DS). The current study explored both the understanding of conventional and novel metaphors and the comprehension of visual metaphors in individuals with NSID (aged 15–59, N = 53) and individuals with DS (aged 15–52, N = 50). Both etiology groups showed poor understanding of verbal and visual metaphor comprehension with worse performance on the visual task. However, the comprehension of novel metaphors was significantly higher than the comprehension of conventional ones, in both groups. As expected, individuals with DS understood fewer conventional metaphors than individuals with NSID, probably due to the linguistic deficiency characterizing individuals with DS. These findings were explained in light of the delay in linguistic ability that characterizes individuals with DS as well as the gradual expansion of their mental lexicon with increasing age.

Figurative language, such as metaphors, metonymies, simile, irony and idioms, is widely used in daily conversation (Lakoff & Johnson, 1980; Pollio, Barlow, Fine, & Pollio, 1977). The ability to comprehend and produce metaphors is critically important for communication (Gibbs, 1994; Lakoff & Johnson, 1980), and reflects the cognitive level of human creativity, the capacity for abstract reasoning and verbal abilities (Friemoth & Kamhi, 1990; Vosniadou, 1987). In order to comprehend metaphors, one must hold enough knowledge to discover a similarity between the two unrelated concepts involved (the vehicle and the target of the metaphorical expression), and to establish the common ground between them by comparison or analogy (Barcelona, 2003; Graesser, Long, & Mio, 1989; Keil, 1986; Shen, 1992; Warren, 1992). There is evidence suggesting that metaphorical comprehension is impaired in individuals with developmental disorders, including autism-spectrum disorders (Baron-Cohen, 1997; Mashal & Kasirer, 2011), learning disabilities (Cain, Oakhill, & Lemmon, 2005; Mashal & Kasirer, 2012), and Williams syndrome (Annaz et al., 2013; Van-Herwegen, Dimitriou, & Rundblad, 2013). Studies examining visual and verbal metaphorical comprehension among individuals with non-specific intellectual disability (NSID) are remarkably scarce; to date only one case study examined metaphorical comprehension in an individual with Down syndrome (DS) (Papagno & Vallar, 2001). The main aim of the current study is to explore verbal and visual metaphorical comprehension among individuals with NSID and individuals with DS.

The current study focused on two types of verbal metaphors: conventional and novel metaphors, which differ in their level of conventionality. The meanings of novel meta-
phors are not coded in the mental lexicon; according to some scholars, they are understood via a comparison processes ("X is like Y") in which the semantic features of both concepts involved (the vehicle and the target) are extracted and then matched with one another (Bowdle & Gentner, 2005). The shared and non-shared elements are then used to establish the ground for the comparison. In contrast, conventional metaphors are understood via a categorization processes ("X is Y") (Glucksberg & Keysar, 1990). Accordingly, the target concept becomes a member in superordinate, abstract metaphorical category, represented by the vehicle term (Glucksberg, 2001). The “career of metaphor” model (Bowdle & Gentner, 2005) combines these two views and suggests that the manner in which a metaphor is comprehended depends on its level of conventionality. This approach postulates a shift in the mode of processing from comparison to categorization as metaphors are conventionalized. Thus, novel metaphors are primarily understood via a comparison process but after repeated use they become conventional. Once conventional, they are understood via a categorization process and their meanings can be easily retrieved from long-term memory (Bowdle & Gentner, 2005; Zharikov & Gentner, 2002).

These two modes of metaphor processing seem to utilize different cognitive abilities. Conventional metaphors are associated with rich language skills, linguistic discourse and knowledge of concepts that enable fast retrieval of their meaning as coded in the mental lexicon (Amanzio, Geminiani, Leotta, & Cappa, 2008; Giora, 1997; Kaufman, 2001). On the other hand, the meaning of a novel metaphor is not coded in the mental lexicon; therefore, it requires formation of a novel interpretation that relies on executive function capabilities such as mental flexibility, preservation and working memory capacity (Friemoth & Kamhi, 1990; Glucksberg, 2008; Mashal & Kasirer, 2011, 2012; Silvia & Beaty, 2012; Vosniadou, 1987) as well as on analogical thinking abilities (Amanzio et al., 2008; Cameron, 1996, 2008; Gentner & Bowdle, 2008; Holyoak & Thagard, 1989; Kaufman, 2001; Kelly & Keil, 1984, Winner, 1979, 1988). Beaty and Silvia (2013) suggested that crystallized intelligence is related to conventional metaphor production, whereas fluid intelligence is associated with the production of novel metaphors. Analogical thinking is one component that comprises fluid intelligence (Lifshitz, Weiss, Tzuriel, & Tzemach, 2011). Several studies have shown a link between analogical and metaphorical thinking (Gentner, 1977; Gentner & Bowdle, 2008; Gibbs, 1994, 2008; Nippold, 1998). Gentner (1983) defines an analogy as mapping information from two concepts while maintaining an equal ratio between them (1:1). Gentner and Bowdle (2008) argued that similar to analogical processing, a metaphor is first and foremost processed symmetrically from the vehicle to the target and vice versa, and only afterwards, an inference is conducted from the vehicle to the target. Thus, analogical and metaphorical thinking establish and share three cognitive components: similarity between elements, inference between the vehicle and the target by matching the relationship between them, and identification of the target or the content to which the metaphor or the analogy refers (Holyoak & Thagard, 1989).

In addition to the two types of metaphors, the current study focused on two presentation modes, visual and verbal. The Metaphoric Triad Test (MTT) examines the ability to comprehend visual metaphors (Kogan, Connor, Gross, & Fava, 1980). In this test, the participants are presented with three pictures (e.g., a baby, a rose bud, a funnel), where two pictures are linked metaphorically (the baby and the rose bud) and one picture is a distractor (the funnel) that forms a literal link to one of the pictures. The ability to comprehend visual metaphors is demonstrated when the participants find the connection between the pair of pictures that relate metaphorically and formulate a sentence that expresses the metaphorical connection between them (e.g., a baby is a rose bud). According to Paivio’s dual coding theory (Paivio, 1991), pictures have an advantage over words since semantic information is coded via two separate rotes. Whereas words are processed only via a verbal route, pictures are processed both via an image pathway and via a verbal code. Thus, pictorial information increases the strength of encoding by accessing semantic knowledge through parallel pathways, facilitating improved recall. The ability to recall visual information...
better than verbal information is known as the “picture superiority effect” (Kail & Siegel, 1977). The study by Defeyter, Russo and McPartlin (2009) demonstrated a developmental trend in the picture superiority effect in recognition memory. According to this study, while 7-year-old children with TD showed preference for words over pictures, the picture superiority effect was exhibited significantly among 9 year olds, 11 year olds and adults.

Both visual metaphors and novel metaphors require processing of items that are not coded in the mental lexicon, and therefore may rely on the recruitment of the same cognitive abilities. Mashal and Kasirer (2012) conducted a principal component analysis in order to examine the interrelationship between various cognitive abilities such as semantic knowledge, executive functions, similarities, reading fluency and the comprehension of visual and verbal metaphors. The results showed that the cognitive abilities required for comprehending visual metaphors and novel metaphors in individuals with TD are similar in relying on executive functions and analogical thinking abilities. Hence, the researchers concluded that the degree of comprehension does not necessarily depend on the metaphorical presentation modality (visual or verbal), but on the conventionality level.

Cognitive Profile of Individuals with Non-specific ID and with Down Syndrome

Individuals with ID constitute a heterogeneous group with differing IQ levels and etiologies. The current study focuses on participants with mild and moderate ID (IQ = 40–70) with NSID and with DS. Individuals with NSID are characterized by linguistic delays, such as poor language competence (Aitchison, 2003; Fink & Cegelka, 1982), limited vocabulary (Borkowski & Büchel, 1983; Cornoldi, Giofre, Orsini, & Pezzuti, 2014), lack of verbal rehearsal and reduced ability in active retrieval of coded information (Hulme & Mackenzie, 1992). They also exhibit difficulties in executive function abilities, such as dealing simultaneously with several aspects of a problem, lack of spontaneous strategy use (Borkowski, Carr, & Pressley, 1987) and difficulty in comprehending abstract relationships between pairs of objects (Paour, 1992). Individuals with NSID show inefficient short-term memory (Reed, 1996) and deficits in the working memory system (Carretti, Belacchi, & Cornoldi, 2010; Cornoldi et al., 2014; Numminen, Service, & Ruoppila, 2002; Schuchardt, Gebhardt, & Maehler, 2010). One might argue that the deficits in the working memory system, especially in the executive functions and inhibition control, might pose barriers in acquiring adequate analogical reasoning in this population (Hulme & Mackenzie, 1992; Inhelder & Piaget, 1958; Jensen, 1970; Conaghy & Kirby, 1987a).

Despite the abovementioned limitations, evidence suggests that ID is not one entity and thus individuals with the same IQ may exhibit strengths and weaknesses in different cognitive domains (Vicari, Albertini, & Caltagirone, 1992). For instance, Vicari et al., (1992) examined the cognitive profile of adolescents with NSID with the same IQ and chronological age (CA) and found poorer performance in verbal ability tasks, visuo-intelligence (as measured by the Raven Matrices test, 1960) and visuo-constructive abilities (e.g. copying and drawing) than in visuo-perceptive abilities (as measured by the overlapping pictures test). These results indicated that some cognitive abilities are better preserved in individuals with NSID than others.

Similar to individuals with NSID, the cognitive profile of individuals with DS is characterized by a global cognitive deficit, although some abilities are better preserved than others. Individuals with DS exhibit a remarkable deficit in language abilities relative to non-linguistic cognitive abilities, especially visual-spatial abilities (Bellugi, Bihlre, Jernigan, Trauner, & Doherty, 1990; Chapman, 1995; Fowler, 1990; Gunn & Crombie, 1996). Similar to individuals with NSID, individuals with DS exhibit difficulties in executive function skills, especially in working memory and in planning capabilities (Costanzo et al., 2013; Lanfranchi, Baddeley, Gathercole, & Vianello, 2012; Lanfranchi, Jerman, Dal Pont, Alberti, & Vianello, 2010). In addition, there is evidence of difficulties in analogical problem solving abilities (Buckley, 1985; Natsopoulos, Christou, Kiutselini, Raptopoulos, & Karefillidou, 2002).
As a result of the cognitive profiles characterizing both etiologies, one might argue that these individuals cannot go beyond a concrete level of reasoning, and would encounter difficulties in comprehending verbal and visual metaphorical language. The effectiveness of intervention programs in helping individuals with ID, with and without DS, acquire higher order cognitive abilities, such as analogical reasoning, is well documented (Büchel, Schlatter, & Scharnhorst, 1997; Hessels-Schlatter, 2002; Lifshitz, Tzuriel, & Weiss, 2005; Lifshitz et al., 2011; Conaghy & Kirby, 1987a, 1987b; Tzuriel & Klein, 1985). These studies demonstrated that adolescents and adults with mild and moderate ID can improve their level in solving conceptual and perceptual analogies as a result of a dynamic assessment procedure. Accordingly, the current study aims to investigate the ability of individuals with NSID and individuals with DS to perform higher level cognitive tasks that rely on analogical reasoning capacity, as required to comprehend metaphorical language.

The picture superiority effect was observed in individuals with NSID and individuals with DS in numerous studies on memory functions (Cherry, Applegate, & Reese, 2002; Dulaney & Ellis, 1991; Leven, Lyxell, Andersson, & Danielsson, 2013; Lifshitz-Vahab & Vakil, 2014; Simon, Rappaport & Agriesti, 1995). These studies suggest that individuals with ID can utilize nonverbal memory codes to support long-term retention as effectively as individuals with TD, and that processing visual information enables individuals with ID to develop the meaning behind visual stimuli better than words alone. Thus, it can be assumed that individuals with ID, with and without DS, will comprehend visual metaphors better than verbal ones. Moreover, the deficit in the linguistic abilities found in individuals with DS is more prominent than other populations with ID, such as individuals with Williams’s syndrome and individuals with NSID (Fowler, Gelman, & Gleitman; 1994; Hulme & Mackenzie; 1992; Mundy, Sigman, Kasari, & Yirmiya, 1988). Accordingly, it can be assumed that individuals with DS will comprehend verbal metaphors (especially conventional metaphors) less well than visual ones and less well than individuals with NSID.

Only few studies have examined the comprehension of metaphorical language among individuals with ID. Most of the studies focused on individuals with Williams syndrome (WS), since they possess high language abilities, compared to their spatial abilities (Jarrold, Baddeley, Hewes, & Phillips, 2001). The results of the studies indicated that participants with WS were less able to comprehend metaphorical language than their TD peers matched on CA. The WS group experienced difficulties in finding the figurative expressions in stories, avoided answering due to the lack of knowledge, and exhibited a tendency to provide more literal interpretations (Annaz et al., 2009). In a comparison between individuals with WS and individuals with TD matched by mental age (MA) and individuals with TD matched by CA, the comprehension of figurative language of participants with WS was significantly lower than that of participants with TD matched by CA, but not significantly different than the comprehension of those with TD matched by same MA (Godbee & Porter, 2013).

Only one case study examined the ability of a woman with DS (CA = 30, verbal IQ = 80, performance IQ = 63) to comprehend verbal metaphors and idioms (Papagno & Vallar, 2001). The general cognitive profile of this woman was exceptional compared to other individuals with DS. While most of individuals with DS are characterized by poor language development and delayed non-verbal cognitive abilities (Chapman, 1995), the results demonstrated reserved language abilities. On the other hand, this woman presented difficulties in executive functions, spatial perception, and comprehension of verbal metaphors and idioms; she showed a preference for giving literal interpretations to explain the metaphorical expressions presented to her. Based on her strengths and weaknesses, the authors concluded that language or literal comprehension is separate from metaphorical language comprehension and the deficiencies in comprehending metaphors and idiom are the results of deficient working memory ability, which is an important component in compre-
hending metaphorical language (Vallar & Pagno, 1993).

The aims of the current study are threefold. The first aim is to examine the differences between verbal and visual metaphorical comprehension within each etiology group. In light of the picture superiority effect (Kail & Siegel, 1977) observed among individuals with and without DS (Cherry et al., 2002; Levén et al., 2013; Simon et al., 1995), we hypothesized that both groups will perform better on the visual metaphor than on the verbal metaphorical test (conventional and novel). The second aim is to examine group differences in comprehension of metaphors on different levels of conventionality (conventional versus novel). We hypothesized that individuals with NSID will exhibit better comprehension of conventional metaphors than those with DS, due to the linguistic delay which characterizes individuals with DS. Regarding group differences in comprehending novel metaphors, we did not have a clear hypothesis since both etiology groups exhibit difficulties in executive functions and analogical abilities, which are associated with the ability to comprehend novel metaphors (Mashal & Kasirer, 2012). The third aim is to test the relationship between metaphorical comprehension (verbal and visual) and three fundamental cognitive abilities required for metaphorical comprehension: linguistic, executive functions, and analogical abilities. We predicted positive correlations between linguistic, executive functions and analogical abilities and comprehending metaphorical language.

Method

Participants

Our sample was comprised of 103 participants with mild and moderate ID (IQ = 40–70) divided into two etiology groups: 53 participants with NSID (30 boys and 23 girls, CA = 15–59) and 50 participants with DS (27 boys and 23 girls, CA = 15–52). The two etiology groups did not differ in gender χ²(1) = .07, p = .79. The linguistic ability of the participants was assessed using the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997), idioms and synonyms. The analogical ability was assessed by using Raven’s standard progressive matrices (Raven, 1960), and these results were used to compare the MA and basic cognitive level of the two etiology groups.

The PPVT has been used to match participants with ID, and measure their vocabulary knowledge (Facon & Facon-Bollengier, 1999). The test consists of 204 items. In each item, participants were presented with four pictures and asked to point to only one picture that represents the word read to them. The score is the total number of correct answers. The discontinuation criterion was six incorrect responses out of eight in the same level. The MA of the participants was calculated according to the test criteria. The Raven test was designed to assess the ability to form comparisons, deduce relationships, correlates, and reason by analogy (Raven, Court, & Raven, 1986). The participants solved sets A, B, C, D and E. In each set, the test was stopped after five consecutive incorrect responses. Correct answers received 1 point. The scores were produced by summarization of the raw scores.

The two etiology groups were also matched according to CA. The differences between groups on the CA, MA and the Raven tests were analyzed by T tests for independent samples. As can be seen in Table 1, the NSID group did not differ significantly from the DS group in these three variables.

Participants were recruited from schools, residential and vocational facilities of adolescents and adults with ID under the supervision of the Division of Chief Scientist of Israel Ministry of Education and the Division of Intellectual Disability of Israel Ministry of Welfare. All of the participants met the criteria set for the current research: individuals with mild/moderate ID according to the traditional

<p>| Table 1 | Summary of Mean and SD for the CA, PPVT and the Raven Tests in the Two Etiology Groups |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th></th>
<th>NSID (N = 53)</th>
<th>DS (N = 50)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>28.49 ± 12.20</td>
<td>27.56 ± 11.43</td>
<td></td>
<td></td>
<td>0.40</td>
</tr>
<tr>
<td>MA</td>
<td>9.79 ± 1.97</td>
<td>9.28 ± 2.08</td>
<td></td>
<td></td>
<td>1.28</td>
</tr>
<tr>
<td>Raven</td>
<td>12.91 ± 3.44</td>
<td>13.72 ± 3.61</td>
<td></td>
<td></td>
<td>−1.17</td>
</tr>
</tbody>
</table>

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AAMR definition (Grossman & Begab, 1983), independent in terms of Activities of Daily Living (ADL) skills and without maladaptive behavior.

Material

The participant’s comprehension of metaphors and executive function abilities were assessed using the phonemic and semantic fluency tests: the Metaphoric Triad Test (MTT), a metaphoric questionnaire, the Trail Making Test (TMT), and the Homophone Meaning Generation Test (HMGT).

Metaphoric Triad Test (MTT)

The MTT examines the comprehension of visual metaphors (Kogan et al., 1980). We used 20 pairs of pictures that have a metaphorical relationship (a lady with closed eyes, shutters). The participants received 1 point if they formulated the relationship between the two pictures as simile (“the eyes of the lady are closed like shutters”) or as a metaphor (“closed eyes are shutters”) for each pair of pictures. A literal relationship (“the women is sleeping in her home”) received 0 points (range 0 –20). Prior to the test, the participants received three examples of paired pictures. The experimenter pointed out the literal and metaphorical relationship for each example pair of pictures in a random order, so the participants could not guess which interpretation is preferable.

Verbal Metaphors

The metaphoric questionnaire tested the participant’s ability to comprehend two types of metaphors: 10 conventional (e.g., sharp tongue) and 10 novel (e.g. pure hand) (Mashal & Kasirer, 2011). For each of the metaphorical expressions, four interpretations were offered: a correct metaphorical interpretation, a literal distracter, an unrelated interpretation, and a fourth choice, “this expression is meaningless.” The metaphorical expressions and the four interpretations were read to the participants. A correct answer received 1 point (ranged 0–10 for each type of metaphor). Furthermore, the participant’s linguistic ability was assessed by idioms and synonyms tests.

Idioms

This test examines the comprehension of idioms (20 items, e.g., “he got cold feet”) (Mashal & Kasirer, 2011). For each, four interpretations were offered: a correct idiomatic interpretation (“he lost courage”); a literal interpretation (“the temperature of his feet lowered”); a literal distracter (“he got a present”); an unrelated interpretation (“he explained himself”). The idiomatic expressions and the four interpretations were read to the participants. A correct answer received 1 point (range 0–20).

Synonyms

The synonyms test is one of the nine scales of the MANN Hebrew test (Glanz, 1989) for vocabulary. The participants were presented with 12 key words and asked to identify a similar word for each, on a list of five other words that were read to them (e.g., “The synonym of the word ‘wall’ is: gate, path, way, balcony or side.”). A correct answer received 1 point (range 0–12).

Participants’ executive functions abilities were assessed using the phonemic and semantic fluency tests, TMT and HMGT.

Phonemic fluency test. The phonemic fluency test examines verbal knowledge, flexibility, and executive control (Kave et al., 2010). The participants were asked to provide as many words as possible beginning with each of three letters (b, g, sh) within 60 seconds. The score is the sum of the words generated for the three letters.

Semantic fluency. The semantic fluency test examines flexibility, and executive control (Kave et al., 2010). The participants were asked to provide as many words as possible in three semantic categories (animals, fruits and vegetables, and vehicles) within 60 seconds. The score is the sum of the words generated for the three categories.

Trail Making Test

The TMT (Reitan & Davison, 1974) examines executive function processes (Espy & Cwik,
and is widely used in neuropsychology studies (Lezak, Howieson, & Loring, 2004). Part A measures visual scanning and tracking, motor speed and focused attention. The participant is asked to draw lines that connect consecutive digits printed in a scattered pattern on the page. Part B measures cognitive flexibility, set shifting and divided attention. The participant is asked to draw lines that connect sequences of letters and digits, alternatively e.g., 1-A-2-B and so on. The total score is the time in seconds needed to complete the two tests. The test was conducted in a population of ID by Smith (1963).

**Homophone Meaning Generation Test**

The HMGT (Mashal & Kasirer, 2011) examines the ability to shift between the different meanings of a homophone (10 items in Hebrew). The participants were presented with 10 sentences in which the final word ended with a homophone (e.g., “He wrote a letter”). The participants were instructed to say aloud all of the meanings of the homophone. A correct answer received 1 point.

**Procedure**

Consent for participation in the study was obtained from the parents or guardians of the participants. Authorizations were obtained from the Ministry of Education, Ministry of Welfare and the University Ethics Committee. The aim and procedure of the study were explained to all participants. All of the participants agreed to participate in the study. They signed an informed consent form for participation in the study. In line with the “normalization principle” (Wolfensberger, 2002), the participants received payment or a gift, according to their choice.

The study was carried out in two stages. In the first stage, each participant was assessed individually using the PPVT and the Raven tests. This stage lasted 2 hours. The tests were administered in a quiet room in the participants’ vocational and residential facilities. The second stage was conducted several days later and was divided into two parts: in the first session, the verbal metaphoric test and the MTT (in a PowerPoint presentation) were administered along with the idioms, HMGT, semantic and the phonemic fluency test. After a 45-minute refreshment break, the synonym and the TMT were administered. This stage lasted two to three hours. The tests were administered to the participants in a fixed order.

**Results**

**Metaphorical Comprehension**

To examine performance on the visual and two verbal metaphor (conventional and novel) tests, the participants’ performance on the three tests was first converted to percentages. Next, we performed a 2×3 repeated measures ANOVA, with group (NSID, DS) as the between-subject variable and the type of metaphor (conventional, novel and visual metaphors) as the within-subject variable.

No main effect of group was found, $F(1,101) = 1.09, p = .30, \eta^2_p = .01$. The main effect of the type of metaphor was significant, $F(2,100) = 107.72, p < .001, \eta^2_p = .68$. Bonferroni *post hoc* analysis indicated that the performance on the visual metaphor test ($M = 7.18\%, SD = 9.64$) was significantly lower than the performance on the novel ($M = 30.29\%, SD = 16.65$), $p < .001$, and the conventional ($M = 19.61\%, SD = 11.37$), $p < .001$ metaphor tests. Furthermore, performance on the novel metaphors test was significantly higher than on the conventional and visual ones, $p < .001$. Moreover, the group X type of metaphor interaction was significant, $F(2,100) = 5.56, p < .01, \eta^2_p = 0.10$. Bonferroni *post hoc* analysis further revealed that the source of the interaction is the higher performance on the conventional metaphors test in the NSID group than in the DS group, $p < .01$. No significant group difference was found for performance on the visual ($p = .18$) and novel metaphor tests ($p = .68$) (see Figure 1).

**Prediction of Metaphor Comprehension Scores by Crystallized and Fluid Scores**

To examine which of the three fundamental cognitive abilities (linguistic, executive functions, and analogical thinking) predict the comprehension of visual and verbal metaphors, we used a set of six hierarchical and stepwise regression analyses, three for each etiology group. We conducted one analysis
with performance on the visual metaphors test as the predicted variable, another analysis using performance on the conventional metaphors test, and a final one using performance on the novel metaphor test. In each regression, we first entered the scores of the background characteristics, PPVT, Raven and CA. Next, we entered the scores on the linguistic tests (idioms and synonyms) and the executive functions tests (fluency tests, TMT and HMGT). The results of the three regression analysis in the NSID group are presented in Table 2 and the results of the three regression analysis in the DS group are presented in Table 3. The order of the variables presented the order of significance.

As can be seen in Table 2, the PPVT scores explained a significant share of the variance in performance on the novel and visual metaphors tests, but not in performance on the conventional metaphor test.

As can be seen in Table 3, the PPVT scores explained a significant share of the variance in performance on the novel and visual metaphors tests, but not on the conventional metaphors test. Furthermore, performance on the Raven test explained a significant share of the variance in performance on the novel metaphor test, but not on the visual and conventional metaphor tests. Scores on executive function abilities, measured by the phonemic fluency test, added significantly to the share of variance in the performance on the conventional and visual metaphors tests. Moreover, the HMGT added significantly to the share of variance in the performance on the novel and visual metaphors tests. The CA contributed to the share of variance only for the performance on the conventional metaphors test.

**Discussion**

There are three main issues at the core of the discussion. The first issue relates to the differences between verbal and visual metaphorical comprehension within each etiology group. The second issue concerns the differences between the two etiology groups in verbal metaphorical comprehension in respect to the con-

**TABLE 2**

Summary of Regression Analysis Predicting Comprehension by CA, Basic Cognitive Level Tests and Scores on Linguistic, Executive Functions and Analogical Tests in the NSID Group (N = 53)

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>R²</th>
<th>Δ R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional metaphors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CA</td>
<td>.13</td>
<td>.02</td>
<td>.13</td>
<td>.03</td>
<td>.05</td>
</tr>
<tr>
<td>PPVT</td>
<td>.00</td>
<td>.01</td>
<td>.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raven</td>
<td>-.03</td>
<td>.05</td>
<td>-.07</td>
<td>.03</td>
<td>.05</td>
</tr>
<tr>
<td>Novel metaphors</td>
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<td>.00</td>
<td>.02</td>
<td>.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPVT</td>
<td>.04</td>
<td>.01</td>
<td>.42**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Raven</td>
<td>.02</td>
<td>.07</td>
<td>.05</td>
<td>.19*</td>
<td>.19*</td>
</tr>
<tr>
<td>Visual metaphors</td>
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</tr>
<tr>
<td>CA</td>
<td>.03</td>
<td>.09</td>
<td>.05</td>
<td>.346***</td>
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<td>.27</td>
<td>.06</td>
<td>.58***</td>
<td></td>
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</tr>
<tr>
<td>Raven</td>
<td>.15</td>
<td>.31</td>
<td>.06</td>
<td>.346***</td>
<td>.346***</td>
</tr>
</tbody>
</table>

**p < .01, ***p < .001.**
ventionality level (conventional versus novel metaphors). The third issue relates to the contribution of linguistic, executive functions and analogical abilities to predicting the comprehension of visual and verbal metaphors.

Verbal and Visual Metaphorical Comprehension of Individuals with NSID and with DS

The main aim of the current study was to explore verbal and visual metaphorical comprehension of individuals with NSID and individuals with DS. In general, the results indicated that the overall performances on the verbal and visual metaphorical comprehension tests in both etiologies were very poor. There are two possible explanations for this finding. First, the cognitive profiles that include delayed linguistic development (Chapman, 1995; Cornoldi et al., 2014; Fowler, 1990), executive functions (Borkowski et al., 1987; Buckley, 1985; Carretti et al., 2010; Costanzo et al., 2013; Hulme & Mackenzie, 1992) and analogical performance (Buckley,

Table 3
Summary of Regression Analysis Predicting Comprehension by CA, Basic Cognitive Level Tests and Scores on Linguistic, Executive Functions and Analogical Tests in the DS Group (N = 50)

<table>
<thead>
<tr>
<th>Predictor Variables</th>
<th>Blocks</th>
<th>B</th>
<th>SE B</th>
<th>β</th>
<th>R²</th>
<th>Δ R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional metaphors</td>
<td>“Block 1”</td>
<td>.02</td>
<td>.01</td>
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*p < .05, **p < .01, ***p < .001.
characterizing both etiology groups, as well as their difficulties in dealing with abstract cognitive problems, may lead to the observed difficulties in comprehending verbal and visual metaphorical language. Second, the poor performance could also result from the fact that individuals with ID rarely use metaphors in everyday life. Indeed, the use of simple sentence structures and concrete phrases rather than abstract ones is well documented in individuals with ID (Borkowski & Büchel, 1983; Conway & Pisoni, 2008; Miolo, Chapman, & Sindberg, 2005).

Contrary to our hypothesis, we found lower comprehension of visual metaphors than verbal metaphors. In light of the picture superiority effect (Kail & Siegel, 1977), we hypothesized that the opposite would be found. There are two possible explanations for this finding. One possible explanation for the lower performance on the visual metaphors test, is that the verbal ones may be related to the MA of the participants. The mean MA in the NSID group was 9.79 and 9.28 in the DS group. The study by Defeyter et al. (2009) demonstrated a developmental trend in the picture superiority effect. According to this study, the picture superiority effect was exhibited among individuals with TD, approximately from the age of 9 through adulthood. The MA of the participants in the current study is close to the lower limit of the MA that is expected to show the picture superiority effect. A second possible explanation may be related to the differences in task requirements. While the verbal tests asked the participants to choose between four choices in the visual metaphors test, the participants had to generate their own metaphorical utterance, based on the pairs of images presented to them. Forming the metaphorical utterance is a demanding task for individuals with ID seeing as they use figurative language infrequently in their daily conversations, preferring a simple, concrete sentence structure over an abstract one (Borkowski & Büchel, 1983; Conway & Pisoni, 2008; Miolo et al., 2005). Furthermore, while in the verbal tests, the participants had to select the correct metaphorical utterance among four choices, in the visual test, the participants also had to ignore irrelevant details related to the main object (e.g., clothes, hair, colors) and to the background, when attempting to generate the metaphorical relation between the two pictures. Intact executive function abilities, particularly inhibition control, are required to accomplish this. Both executive functions and analogical thinking abilities are delayed among individuals with NSID (Hulme & Mackenzie, 1992) and among individuals with DS (Buckley, 1985).

Conventional and Novel Metaphorical Comprehension among Individuals with NSID and with DS

As we hypothesized, individuals with NSID were better at comprehension of conventional metaphors than individuals with DS. The comprehension of conventional metaphors is associated with crystallized intelligence and is based on meaning retrieval from the mental lexicon (Amanzio et al., 2008). Individuals with DS are characterized by having a linguistic deficiency (Chapman, 1995; Fowler, 1990) that impairs the comprehension of conventional metaphors.

Regarding the conventionality level of the metaphorical utterances, the results indicated that the comprehension of novel metaphors was significantly better than the conventional ones in both groups. This finding is surprising due to the higher cognitive demands required for the processing of novel metaphors compared to conventional ones. The comprehension of novel metaphors requires higher comparative ability that places higher demand on working memory, while the comprehension of conventional metaphors is an easier task that relies on the automatic process of meaning retrieval (Mashal, 2013). One possible explanation for this surprising finding may be the fact that the meanings of conventional metaphors, same as novel ones, are not coded in the mental lexicon of individuals with ID, therefore, conventional metaphors hold no advantage over novel ones. Due to the rare use of metaphors in populations with ID, all metaphorical utterances are perceived as novel. However, the reason that the participants understood fewer conventional metaphors than novel metaphors, even if they perceived them as unfamiliar, is unclear.

One possible explanation may be related to the level of the metaphorical “opacity.” Metaphors can be characterized by their level of opacity (Levorato & Cacciari, 2002). The con-
ceptual relation between the vehicle and the target terms is easily inferable in “transparent” metaphors but in “opaque” metaphors, the conceptual relation between the two terms is not so easily inferable and more complex mapping is required. Comprehending transparent metaphors involves an inference process in which the conceptual similarity between the two terms is clear, while comprehending opaque metaphors requires the retrieval of their meaning as stored in long term memory. It is possible that the participants were better able to comprehend the novel metaphors since they were more transparent than conventional ones. For instance, the novel metaphor “safe secrets” could be more transparent and easily comprehensible to a person who has kept secrets within himself, much like a safe, whereas the conventional metaphor “deafening silence,” is more opaque, abstract and difficult to comprehend.

Another possible explanation for the better comprehension of novel metaphors in individuals with DS may be related to the atypical brain lateralization observed in this etiology. There is evidence suggesting a link between novel metaphor comprehension and increased activity in the right hemisphere language brain regions (in temporal regions homology of the classical language comprehension area, Wernicke’s area) (Faust & Mashal, 2007; Mashal, Faust, Hendler, & Jung-Beeberman, 2007). Conversely, the comprehension of conventional metaphors and literal expressions is associated with increased activity in the classical language (Broca and Wernicke) areas of the left hemisphere. Many studies examining brain functions and lateralization in language tasks have shown that there is atypical brain lateralization in individuals with DS, compared to individuals with TD. For instance, while individuals with TD exhibit right ear advantage during the processing of linguistic stimuli, studies among DS showed a left ear advantage (Chua, Weeks, & Elliot, 1996; Elliott & Weeks, 1993; Grouios, Ypsilanti, & Koidou, 2013; Heath & Elliot, 1999; Menghini, Costanzo, & Vicari, 2011; Paquette, Bourassa, & Peretz, 1996). The left ear advantage indicates that the right, rather than the left, hemisphere is dominant for language processing among individuals with DS. It is possible that the right hemisphere advantage led to better performance on the novel metaphor test among individuals with DS. It could be assumed that this possible explanation is true even for participants with NSID, who presented similar findings. However, further studies exploring hemispheric lateralization and its relationship to metaphor comprehension among individuals with NSID and DS are required.

**The Contribution of Linguistic, Executive Functions and Analogical Abilities to the Prediction of the Comprehension of Verbal and Visual Metaphors**

The results of the regression analyses showed a significant contribution of vocabulary (PPVT) to the prediction of the comprehension of novel and visual metaphors (but not of the conventional ones) in both etiology groups. These findings are consistent with previous studies, pointing to the importance of verbal abilities to metaphor comprehension (Frimemoth & Kamhi, 1990; Vosniadou, 1987). In the DS group, in addition to the contribution of vocabulary, executive functioning (as assessed by the HMGT) contributed to explaining the variance of the novel metaphor comprehension. Numerous studies found a connection between the executive functions and the ability to comprehend metaphorical expressions among participants with TD (Frimemoth & Kamhi, 1990; Glucksberg, 2008; Mashal & Kasirer, 2011; Silvia & Beaty, 2012; Vosniadou, 1987). It is possible that the additional contribution of executive functions abilities to explaining the variance of the performance in the novel metaphors test occurs due to the linguistic delay that characterizes individuals with DS. This delay might lead the participants with DS to rely on their other capabilities in order to find the relationship between the pairs of images in the visual metaphors test.

Executive functions (HMGT, phonemic fluency test) also contributed to the prediction of visual metaphor comprehension among the DS group alone. This finding corroborates the results of the study by Mashal and Kasirer (2012). According to this study, comprehending novel and visual metaphors relies on executive function abilities required for the formulation of their interpretations. The HMGT examines the ability to shift between different
meanings of a homophone, and relies mainly on mental flexibility, a component of executive function (Mashal & Kasirer, 2011). Mental flexibility enables the selection of the relevant attributes of the vehicle and the target term and the switching between the literal and the metaphorical interpretations of a novel metaphor (Friemoth & Kamhi, 1990; Glucksberg, 2008; Mashal & Kasirer, 2011, 2012; Silvia & Beaty, 2012; Vosniadou, 1987). Similarly, understanding a visual metaphor requires the selection of relevant features of the two pictures and the creation of a metaphorical interpretation.

Non-verbal intelligence (as assessed by Raven) was also found to make a significant contribution to predicting novel metaphor comprehension in the DS group. The Raven matrices tests fluid intelligence and assesses analogical reasoning. Studies showed a correlation between the fluid and analogical abilities and the ability to comprehend metaphorical expressions (Gentner, 1977; Gentner & Bowdle, 2008; Gibbs, 1994, 2008; Nippold, 1998; Silvia & Beaty, 2012; Yosef, 2011). It can be assumed that the delay in language ability among individuals with DS, led the participants to rely not only on their linguistic ability but also on their executive functions and analogical reasoning abilities in order to find the relevant attributes of the vehicle and the target terms in the novel metaphors test.

The factors contributing to predicting the comprehension of conventional metaphors were different. Our results showed a significant contribution of both CA and performance on the phonemic fluency test in the DS group but not in the NSID group. The comprehension of conventional metaphors increases along with the participant’s age (Gardner, 1974; Nippold, 1998). It can be assumed that the contribution of CA in the DS group, who exhibited a remarkable deficit in language abilities, may indicate gradual expansion of the mental lexicon in this population with increasing age. The gradual expansion of the mental lexicon facilitates fast retrieval of the meaning of conventional metaphors (Giora, 1997). Moreover, there is evidence that the recognition of conventional metaphors by adults with TD is mostly based on phonological information maintained in the working memory (Mashal, 2013). The results of our study support these findings and show a significant contribution of the phonemic ability to the prediction of conventional metaphor comprehension, even in individuals with DS.

Taken together, the results of the current study suggest that individuals with ID are impaired in verbal and visual metaphor comprehension. Contrary to our expectation, based on the “picture superiority effect,” individuals with and without DS are impaired mostly in visual metaphor comprehension. Further studies are required in order to examine the effect of intervention programs on acquiring visual metaphorical comprehension among these populations. Regarding the conventionality level of the metaphorical utterances, the results indicated that the comprehension of novel metaphors was significantly better than conventional ones across groups. Our results also indicated that individuals with DS rely on different cognitive abilities rather than individuals with NSID, when interpreting metaphorical language. Linguistic ability (PPVT) contributed to novel metaphor comprehension in both groups, but analogical reasoning ability and mental flexibility also contributed to novel metaphor comprehension in the DS group. Moreover, the comprehension of conventional metaphors among the DS group was significantly lower than among the NSID group. The DS but not the NSID group demonstrated that better comprehension of conventional metaphors is linked to greater chronological age. We explained these findings in light of the delay in linguistic ability which characterizes individuals with DS and the gradual expansion of the mental lexicon with increasing age. Our findings may have educational implications and indicate the need for interventions for individuals with and without DS who exhibit a remarkable deficit in metaphor comprehension, particularly for visual metaphors.

References


