



# Principal component analysis study of visual and verbal metaphoric comprehension in children with autism and learning disabilities

Nira Mashal\*, Anat Kasirer

School of Education, Bar-Ilan University, Ramat-Gan 52900, Israel

## ARTICLE INFO

### Article history:

Received 3 September 2011

Received in revised form 6 September 2011

Accepted 6 September 2011

Available online 15 October 2011

### Keywords:

Autism

Learning disabilities

Visual metaphors

Principal component analysis

Semantic knowledge

## ABSTRACT

This research extends previous studies regarding the metaphoric competence of autistic and learning disabled children on different measures of visual and verbal non-literal language comprehension, as well as cognitive abilities that include semantic knowledge, executive functions, similarities, and reading fluency. Thirty seven children with autism (ASD), 20 children with learning disabilities (LD), and 21 typically developed (TD) children participated in the study. Principal components analysis was used to examine the interrelationship among the various tests in each group. Results showed different patterns in the data according to group. In particular, the results revealed that there is no dichotomy between visual and verbal metaphors in TD children but rather metaphor are classified according to their familiarity level. In the LD group visual metaphors were classified independently of the verbal metaphors. Verbal metaphoric understanding in the ASD group resembled the LD group. In addition, our results revealed the relative weakness of the ASD and LD children in suppressing irrelevant information.

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## 1. Introduction

Metaphors play a natural and often a necessary role in the mundane language of everyday interaction. Developing metaphor competence enables children to use metaphor for reaching shared understandings and for learning. It has been suggested that the processes underlying metaphor are basic to human development from infancy and that “metaphor provides one of the basic ways of learning about the world. Its mapping of different, previously unrelated domains onto each other is seen to extend children’s knowledge to that which is unfamiliar, thus making it a tool as well as a skill” (Marschark & Nall, 1985, p. 54). Metaphor understanding gradually develops throughout childhood into adulthood simultaneously with other cognitive capacities as well with the development of world knowledge (Vosniadou & Ortony, 1983). It involves awareness of similarities and relations between different domains and the integration of analogous elements into novel concept. Keil (1986) argued that to understand metaphors one must have enough knowledge to discover a similarity between the two concepts involved (the topic and the base term of the metaphoric expression). It is therefore not surprising that these requirements impose considerably figurative language impairments on special populations, such as autism and learning disabilities, which results in a tendency to interpret figurative utterances literally (e.g., Friemoth Lee & Kamhi, 1990; Roundblad & Annaz, 2010). Norbury (2005) found that ASD children with language deficits were impaired on metaphor comprehension task and that they were indistinguishable from non-autistic children with language impairment, suggesting that semantic knowledge is a key determinant of metaphor comprehension. In the current study we aim to deepen our

\* Corresponding author. Tel.: +972 3 5317178.

E-mail address: nmashal2@gmail.com (N. Mashal).

understanding of the relationships between metaphoric competence and various cognitive abilities in children with autism and learning disabilities and to compare them to those of typically developed (TD) children.

Accumulating evidence suggests that children with autism (ASD) exhibit figurative language comprehension deficits and especially metaphoric impairments (Happé, 1993, 1995; MacKay & Shaw, 2004; Roundblad & Annaz, 2010). Some researchers have reported similar non-literal language comprehension deficits in LD children (e.g., Friemuth Lee & Kamhi, 1990; Nippold & Fey, 1983). However, studies that directly compared figurative language comprehension in both ASD and LD children are remarkably scarce. A recent study that compared non-literal language comprehension as well as performances in fluency tests and homophone meaning generation test in both individuals with autism (aged 12–15) and learning disabilities (aged 12–13) demonstrated difficulty in interpreting non-literal expressions in multiple choice tests as compared with TD children (aged 12–13) (Mashal & Kasirer, 2011). Significant differences were found in the understanding of idioms (e.g., “he got cold feet”), conventional metaphors (e.g., “defense line”), meaningless word pairs (e.g., “sport lemon”). ASD and LD children provided more literal interpretations to idioms and in addition, interpreted meaningless two word expressions more often than TD children. No differences were observed between the ASD and the LD group indicating a similar non-literal language profile for both groups. This finding pinpoint the difficulty of both groups to access and select relevant and affective conceptual information about topic and base term domains, and to construct links that enable resolution of the incongruity between the topic and the base term. For example, understanding the metaphoric expression “Family is a cradle”, in which “family” represents the topic and “cradle” the base term, requires the generation of a broad range of associations to each concept and then, the simultaneously selection of the appropriate shared properties, such as safety and comfort and the suppressions of the irrelevant ones (e.g., swinging) (an example adopted from Lundgren, Brownel, Soma, & Cayer-Meade, 2006).

The source of this metaphorical difficulty among ASD and LD children is still unknown. It could be that the metaphoricity *per-se* is intact but the use verbal stimuli exerts additional cognitive demand on children with autism and especially, children with learning disability, who suffer from reading impairments. The occurrence of metaphors is not restricted to language and the verbal domain but rather metaphors are pervasive in pictures, commercials, movie scenes, and art. Visual metaphors offer a non-verbal means to convey metaphorical messages that may be beneficial for some individuals because it engages a process of adapting information from an external visual structure, that bypass the verbal mediation, to one’s internal conceptual structures. Very little is known about the similarities or differences between visual and verbal constructs in the assessment of LD and ASD children metaphoric understanding. Friemuth Lee and Kamhi (1990) studied visual and verbal metaphoric understanding of children with LD, children with LD with a history of spoken language impairments, and TD children ranging in age from 9 to 11 years. Visual metaphoric understanding was tested by the metaphoric triad test (MTT) that was developed by Kogan, Connor, Gross, and Fava (1980). The MTT consists of 29 triads of pictures, each offering three pairing possibilities, in which one is metaphoric (e.g., *angry man, thunderstorm, man in the rain*, in which the pictures of the angry man and the thunderstorm are metaphorically associated). Identification and correct metaphoric explanation contribute to higher scores. The performance of both LD groups on the verbal tasks was poorer than the performance of TD children. Despite the lower scores of the LD children, visual metaphor understanding did not differ between the LD and the TD group. These results suggest that LD children benefit more from pictorial metaphors than verbal metaphors. In the current study we aimed to examine the relationship between visual and verbal metaphors understanding in both ASD and LD children and in particular, to assess whether visual metaphoric comprehension is a distinct capacity than verbal metaphors.

Autism is a distinct disorder than learning disability, with the former identified as a neurodevelopmental disorder characterized by debilitating socioemotional impairments, and the last is identified as perceptual disabilities, brain injury, minimal brain dysfunction, and dyslexia. Although the etiology of these disorders differ, some researchers have shown that in addition to the shared figurative language comprehension deficits both groups demonstrate some inferior executive function performances (Cutting, Materek, Cole, Levine, & Mahone, 2009; Mashal & Kasirer, 2011; Minshew, Goldstein, Muenz, & Payton, 1992; Russell, 1997; Whitney, Mahone, Levine, Eason, & Cutting, 2009). Executive function consists of higher order skills such as inhibition, working memory, planning, mental flexibility, organizing, and self-monitoring, presumably subserved by the frontal lobes, as evidenced by lesion studies showing that patients with prefrontal lesions have deficits in these areas of functioning (Shallice, 1982). On tests of word fluency where one must produce as many words as possible in one minute, ASD have been shown to be impaired in relation to non-autistic, age, and ability matched controls (Minshew et al., 1992). Executive dysfunction seems to underlie many of the key symptoms of autism, both in the social and in the non-social domains. For example, Turner (1997) reported an association between poor performance on ideational and design fluency tasks and high levels of repetitive behavior in daily life. Mashal and Kasirer (2011) found an association between both phonemic fluency test and homophone meaning generation test and novel metaphors comprehension in ASD children. However, not all studies found poorer performances of ASD compared to TD children in fluency tests (e.g., Boucher, 1988): ASD children were unimpaired in relation to both learning-disabled and age-matched children when generating words belonging to a specific category (e.g., colors, animals). As for LD children, some evidence suggests that executive functions account for a substantial amount of variance in reading comprehension. A recent study that investigated children with adequate word reading accuracy but who develop specific reading comprehension deficits found an association between inferior executive functions and reading comprehension (Cutting et al., 2009). Thus, both ASD and LD exhibit similar profile in figurative language understanding and there is evidence that both are impaired in executive functions. Linking underlying cognitive processes and in particular, executive dysfunctions associated with ASD and LD to the insufficient body of literature on visual and verbal metaphor comprehension is essential for ultimately understanding underlying processes of metaphor comprehension in these special populations.

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