



Profiles of visual perceptual functions in Down syndrome



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ABSTRACT

The primary purpose of this study was to investigate the visual perceptual functions measured by the Test of Visual Perceptual Skill-Third Edition (TVPS-3) in Down syndrome (DS). Seventy individuals with DS, seventy with typical development (TD), and forty mental-age-matched participants with intellectual disabilities (ID) were recruited for the assessment session. Significant between-group differences in TVPS-3 were observed between either DS or ID and TD groups. There was no significant difference on TVPS-3 between DS and ID groups. Implications for clinical professionals and recommendations for further research are discussed.

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1. Introduction

Down syndrome (DS) is the most common genetic cause of intellectual disabilities (ID) (Picker & Walsh, 2013), with prevalence of 1 in 737 live births (Parker et al., 2010). Most previous studies have stressed that the neuropsychological profile of DS is mainly characterized by a remarkable deficit in language abilities solely (Abbeduto, Warren, & Connors, 2007; Chapman, 1997). Much of the research that established visuo-spatial ability as a relative strength in DS however, contrasted it with verbal and other cognitive abilities (Klein & Mervis, 1999; Wang & Bellugi, 1994; Wang, Doherty, Rourke, & Bellugi, 1995). Therefore, visual perceptual functions are rarely discussed or even treated in DS compared to other groups of ID such as Williams syndrome (WS) or fragile X syndrome (FXS). Recent studies from different labs have demonstrated more complex neuropsychological features in DS, with deficits in visual perceptual functions as well (Vicari, 2006). The study results showed that DS have deficits in the following visual perceptual functions: mental rotation (Hinnell & Virji-Babul, 2004; Uecker, Obrzut, & Nadel, 1994), visual organization (Wuang & Su, 2011), figure ground and visual imaginary (Vicari, Bellucci, & Carlesimo, 2006), and visuospatial working memory (Carretti, Lanfranchi, & Mammarella, 2013; Lanfranchi, Carretti, Spanò, & Cornoldi, 2009). In addition, on the tasks requiring organization of the visual stimuli from part to whole, like house drawing, block designing and local-to-global tasks; DS tend to exhibit a global organization while ignoring internal details (Bellugi, Lichtenberger, Mills, Galaburda, & Korenberg, 1999).

Since visual perceptual functions are less understood in DS, utilization of appropriate assessment tools to evaluate their performance on visual perceptual tasks is of importance. The most commonly used assessments of visual perception by

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occupational therapists are Development Test of Visual Perception, Second Edition (DTVP-2; Hammill, Pearson, & Voress, 1993), Motor-Free Visual Perception Test, Third Edition (MVPT-3; Colarusso & Hammill, 2003), and Test of Visual Perceptual Skill, Third Edition (TVPS-3; Martin & Gardner, 2006). The above tests all have good psychometric properties; the TVPS-3 was chosen in the present study because it has been designed to analyze comprehensive visual perceptual functions framed by seven over-arching dimensions. The test items are arranged according to difficulty (from the easiest to the most difficult), and it only requires verbal responses to the test items. It is particularly suitable for children with disabilities (i.e. DS in the present study) because of their poor motor abilities and low frustration tolerance levels.

The study aimed to assess the visual perception of functions in DS by using the standardized visual perception test (TVPS-3) and determine whether their visual perceptual functions were age-linked like typically-developing individuals.

2. Materials and methods

2.1. Participants

Three groups participated in this study. Individuals with DS and ID were recruited from two public special schools, 2 non-profit agencies serving disabled citizens, and 3 hospitals in southern Taiwan. In these settings, individuals were selected for participation if they met the following criteria: they (1) were aged between 6 and 20 years; (2) had a diagnosis of DS defined by board-certified physicians with a full-scale IQ of 55–70 on Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV) (Wechsler, 2003) or Wechsler Adult Intelligence Scale, Third Edition (WAIS-III) (Wechsler, 1997); (3) did not receive any visual perceptual training program in the preceding year; (4) were without serious emotional or behavioral disturbances; and (5) were right-handed. Excluded were those carrying coexisting autism, cerebral palsy, blindness and deafness in an attempt to minimize confounding of data. Also excluded were individuals with known etiologies of ID (e.g., WS, FXS, etc.) or previous history of neurological disorders such as traumatic brain injury, muscular dystrophies, and epilepsy. The TD group was recruited by contacting school nurses at 11 mainstream schools. Participants were excluded if screening of school medical records revealed any history of diagnosis of developmental, intellectual, psychiatric, or physical disabilities. The TD and DS groups were matched for chronological age, and ID and DS group was matched for IQ (mental age). The three groups were matched for gender and socioeconomic status as well.

2.2. Measures

In the present study, TVPS-3 (Martin & Gardner, 2006) was used to assess the visual perceptual functions in DS. The TVPS-3 assesses visual perception for individuals aged 4 years to 18 years 11 months in seven comprehensive subtests: visual discrimination, visual memory, visual spatial relationship, visual form constancy, visual sequential memory, visual figure-ground, and visual closure. The established norm of age 18 years could also be applied while assessing the visual perception functions of older adults (Brown, Mullins, & Stagnitti, 2008).

TVPS-3 is an individually administered test, and it takes approximately 30–40 minutes to complete. All seven subtests include 2 trial items and 16 formal items, which are presented in multiple-choice formats. The raw score of seven subtests and total score can be converted to scale score and percentile rank. The average age-adjusted scale score for subtests are 10 ($SD = 3$) and average age-adjusted standard score for total scores is 100 ($SD = 15$). The test–retest reliability is .97 (Martin & Gardner, 2006). The TVPS-3 correlated fairly well with other measures of visual perception such as MVPT-3 and the Developmental Test of Visual Perception, Adolescent and Adult (Reynolds, Pearson, & Voress, 2002); the correlation coefficient ranged from 0.39 to 0.51 (Brown, Mullins, & Stagnitti, 2009).

2.3. Procedure

This study was conducted during 2010–2014. Informed consent was obtained from the participant and his/her parent or guardian using assent (for the adolescents) and consent (for parent/guardian) forms approved by the Institutional Review Board of Kaohsiung Medical University Hospital. All the assessments were conducted on an individual basis in a specially designated space in the respective schools or facilities by experienced occupational therapists. After consent had been granted, the therapist used TVPS-3 to assess the visual perceptual functions of 70 TD, 70 DS, and 40 ID.

2.4. Data analysis

The raw scores of seven subtests and total score of the TVPS-3 was used for further data analysis by SPSS 18.0.

2.4.1. Inter-groups analysis

Analysis of variance (ANOVA) was applied to investigate the difference on visual perceptual functions among DS, ID, and TD groups.

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