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Matching variables for research involving youth with Down syndrome: Leiter-R versus PPVT-4

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ABSTRACT

Much of what is known about the cognitive profile of Down syndrome (DS) is based on using either receptive vocabulary (e.g., PPTV-4) or nonverbal ability (e.g., Leiter-R) as a baseline to represent cognitive developmental level. In the present study, we examined the relation between these two measures in youth with DS, with non-DS intellectual disability (ID), and with typical development (TD). We also examined the degree to which these two measures produce similar results when used as a group matching variable. In a cross-sectional developmental trajectory analysis, we found that the relation between PPVT-4 and Leiter-R was largely similar across groups. However, when contrasting PPVT-4 and Leiter-R as alternate matching variables, the pattern of results was not always the same. When matched on Leiter-R or PPVT-4, the group with DS performed below that of the groups with ID and TD on receptive grammar and below the group with TD on category learning. When matched on the PPVT-4, the group with ID performed below that of the group with TD on receptive grammar and category learning, but these differences between the groups with ID and TD were not found when matched on the Leiter-R. The results of the study suggest that the PPVT-4 and Leiter-R are interchangeable at least for some outcome measures for comparing youth with DS and TD, but they may produce different results when comparing youth with ID and TD.

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Much of what is known about the cognitive profile of individuals with Down syndrome (DS) is based on using either receptive vocabulary or nonverbal ability as a baseline to represent cognitive developmental level. These are thought to be appropriate choices because both are relatively unaffected by the expressive and grammatical language impairments characteristic of this population. However, little work has directly compared differences in using these two types of measures as matching variables, and most researchers do not provide a rationale for selecting one type of measure over the other. The aim of the current study was to examine the relation between a receptive vocabulary measure, the Peabody Picture Vocabulary Test-4th edition (PPVT-4; Dunn & Dunn, 2007), and a nonverbal ability measure, the Leiter International Performance Test-Revised (Leiter-R; Roid & Miller, 1997), in youth with DS compared to youth with non-DS intellectual disability (ID) and to children with typical development (TD). Further, we examined the degree to which these two measures produce similar results when used as a group matching variable.

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1. Methodological issues in matching

When conducting behavioral research in the field of ID, major methodological challenges exist. With an inability to randomly assign participants to either the target group or the comparison group, quasiexperimental designs are required, which limit causal inferences. Additionally, small sample sizes due to low prevalence rates restrict methodological designs and statistical procedures. Consequently, one of the most common methods utilized in ID research is the group-match design, but this design brings its own host of concerns (Beeghly, 2006; Burack, 2004; Eigsti, de Marchena, Schuh, & Kelley, 2011; Kover and Atwood, 2013). In a group-match design, participants from two or more preexisting groups (e.g., Down syndrome and typically developing) are matched on one or more variables such as IQ, chronological age (CA), or mental age (MA); once matched, participants are compared on the dependent variable(s). The matching variable is selected based on its supposed relation to the dependent variable(s), and when matched, groups are considered equivalent on the matching variable. Therefore, when differences between groups are found, one can conclude whether or not that particular construct is a strength or weakness for the group with ID relative to the matching variable, which is often interpreted as a proxy for general developmental level (e.g., whether or not visuospatial ability is a strength or weakness for individuals with DS relative to their MA). Beyond the scope of the current paper but still an issue of major concern is how to determine group equivalence on the matching variable (e.g., using p values vs. effect sizes; see Kover and Atwood, 2013).

The other primary issue with the group-match design, and the focus of the current discussion, is how to appropriately match participants (e.g., Burack, Iarocci, Bowler, & Mottron, 2002; Mervis & Klein-Tasman, 2004; Mervis & Robinson, 1999; Silverman, 2007; Strauss, 2001). The broadest decision about matching participants is whether to select a comparison group based on CA or MA (for review, see Burack et al., 2002; Chapman & Hesketh, 2000). When matching a group with ID to a TD group on MA, researchers can eliminate the expected delays in development due to the group with ID's lower cognitive functioning. By setting groups equivalent on a general level of cognitive functioning, researchers can determine relative strengths and weaknesses after accounting for the known general delay. Matching on MA typically results in group comparisons with significantly different CA, which means different biological maturation and life experiences that can influence task performance. However, matching on developmental level is usually preferred to matching on CA for detecting relative strengths and weaknesses and providing information about cognitive behavioral profiles.

Another key consideration for matching participants is the developmental profile of the target population (for review, see Burack et al., 2002; Chapman & Hesketh, 2000). When selecting a variable on which to match participants, researchers must consider the developmental strengths and weaknesses of the target population. If not accounted for, the matching variable may underestimate or overestimate the cognitive ability of the target group. For example, verbal tests may underestimate the cognitive abilities of individuals with autism while nonverbal ability measures may overestimate their cognitive abilities (Shah & Frith, 1993). Matching on different variables has the potential to influence the results of a study, as shown by Ozonoff, Pennington, and Rogers (1990) when they examined emotion perception in individuals with autism compared to TD individuals. They found that emotion perception was delayed in individuals with autism when they were matched on nonverbal MA but not when they were matched on mean length of utterance (a verbal measure). Additionally, if the matching variable is not related to the variable of interest, the results may be affected (Burack et al., 2002). For example, it makes more sense to use a nonverbal ability measure rather than a verbal ability measure to match groups when examining visuospatial skills. While this will diminish the likelihood of finding significant differences between groups, researchers can be more confident that their results truly demonstrate the relative strength or weakness of the target skill. Therefore, researchers are encouraged to consider both the participant characteristics and the research question when selecting a matching variable.

One suggested method for handling discrepancies associated with the selection of different matching variables is to include more than one comparison group and match on several measures of cognitive development (e.g., one comparison group matched on verbal ability and one comparison group matched on nonverbal ability; Hobson, 1991). This allows researchers to better determine strengths and weaknesses within specific domains of cognitive abilities and ideally provide an enhanced understanding of the target group's level of functioning; however, such a design places an increased burden on the researcher in terms of recruitment and testing. The current study utilized such a technique by including separate analyses where participants were either matched on nonverbal ability or receptive vocabulary to determine how results may be affected based on these different matching variables.

2. Cognitive-linguistic profile of Down syndrome

These issues with matching are particularly relevant in DS research, where one must take into consideration the unique profile of individuals with DS when selecting a matching variable. DS is the most common genetic disorder that results in ID. It is caused by an extra copy of chromosome 21 (i.e., Trisomy 21) and affects approximately one in 691 live births (Parker et al., 2010). Individuals with DS experience impairments in cognitive, emotional, and physical development including a moderate to severe intellectual delay with an average IQ range of 30–70. They also have a distinct cognitive-linguistic profile. Based on verbal and nonverbal MA comparisons, speech, language, and verbal short-term memory are all areas of clear impairment in DS (for reviews, see Abbeduto, Warren, & Conners, 2007; Baddeley & Jarrold, 2007; Chapman & Hesketh, 2000; Kent & Vorperian, 2013; Næss et al., 2011). While verbal abilities are a clear weakness for individuals with DS, visuospatial processing is not quite as impaired (Jarrold & Baddeley, 1997; Jarrold, Baddeley, & Hewes, 1999; Silverstein,