# Verbal Fluency and Executive Functioning Skills of Young Adults with Down Syndrome

Kayla Kristensen[1], MS, CCC-SLP; Xin Zhou[1], PhD; Brianna Piro-Gambetti[1,2], MS; Sigan L. Hartley[1, 2], PhD; Shelly Godar[1], MA, CCC-A and Ruth Y. Litovsky[1], PhD

[1]Waisman Center, University of Wisconsin-Madison, WI, United States
[2]School of Human Ecology, University of Wisconsin-Madison, WI, United States

## BACKGROUND

Both language and executive functioning skills are associated with verbal fluency for young adults without Down syndrome (DS) [1]. There is emerging evidence of relationships between receptive vocabulary and verbal fluency for children with DS [2] and verbal short-term memory and verbal fluency for adults with DS [3]. Additionally, strategies including clustering and switching have been associated with verbal fluency performance for children and adults with DS [2, 3]. Number of clusters has also been associated with receptive vocabulary for children with DS [2]. It is unknown how switching and clustering may be related to executive functioning skills for individuals with DS.

Increased understanding of associations between language and executive functioning can inform clinical interpretation of verbal fluency tasks.

## OBJECTIVES / AIMS

The aim of the current study is to describe associations between verbal fluency, receptive vocabulary, and executive functioning skills in young adults with DS with a special focus on verbal fluency strategies, specifically clustering and switching.

## DESIGN / METHODS

As a part of a larger cross-sectional study, 19 individuals with DS completed measures of verbal fluency, receptive vocabulary, and executive functioning. Please see Table 1 for sociodemographic information.

**Verbal fluency:**
NEPSY-II Animal and Food Semantic Verbal Fluency tasks [4] with clustering and switching analysis [5, 6]
- **Total correct, total and mean size of clusters, total switches**
- **Cluster** = sequence of at least two consecutive words that belong to a subcategory (e.g., cow, goat, sheep); Clustering is considered automatic and mediated by the temporal lobe [7]
- **Switch** = shift from one subcategory to another subcategory or unrelated word (e.g., whale, cow, goat, sheep, zebra); switching is considered strategic and mediated by the frontal lobe [7]

**Receptive vocabulary:**
Peabody Picture Vocabulary Test – Fifth Edition (PPVT-5) [8]
- **Receptive vocabulary age (years)**

**Executive functioning:**
Haxby Extended Block Design as a measure of fluid reasoning [9]
- **Total correct**

Cat and Dog Stroop Task as a measure of inhibition [10]
- **Time during switching condition (seconds)**

WISC-IV Digit Span Backwards as a measure of verbal working memory [11]
- **Total correct**

WISC-Integrated Corsi Span Backward Task as a measure of nonverbal working memory [12]
- **Total correct**

Pearson correlations were conducted with p<.05 indicating significance

## PARTICIPANTS / RESULTS

**Table 1.**
**Sociodemographic, cognitive, and receptive vocabulary information for 19 young adults with DS**

| | |
|---|---|
| Type of DS (n, (%)) | |
| Trisomy 21 | 15 (79) |
| Mosaicism | 1 (5) |
| Translocation/partial | 1 (5) |
| Unknown | 2 (11) |
| Chronological Age in years (M ± SD; Range) | 22.20 ± 1.70; 19-24 |
| Biological Sex (n, (%)) | |
| Male | 9 (47) |
| Hearing Status* (n, (%)) | |
| Normal | 9 (47) |
| Mild-to-moderate hearing loss | 9 (47) |
| Unilateral profound hearing loss | 1 (5) |
| KBIT-2 (M ± SD; Range) | |
| Nonverbal Mental Age in years | 5.58 ± 2.41; 4.00-11.67 |
| Verbal Mental Age in years | 6.88 ± 2.70; 4.00-11.33 |
| PPVT-5 (M ± SD; Range) | |
| Receptive Vocabulary Age in years | 8.13 ± 2.89; 3.17 – 15.33 |

**Note**: KBIT-2 = Kaufman Brief Intelligence Test-Second Edition [13]. *Hearing status was examined using a pure-tone hearing threshold test through air conduction and bone conduction as appropriate. Two individuals with moderate hearing loss used hearing amplification. The individual with unilateral profound hearing loss did not use amplification and had normal to borderline normal hearing in the unaffected ear.

**Table 2.**
**Correlates of verbal fluency total score**

| | Verbal fluency total score |
|---|---|
| Receptive vocabulary age | r = .47, p = .042 |
| Fluid reasoning | r = .58, p = .009 |
| Inhibition | r = -.49, p = .037 |
| Verbal working memory | r = .69, p = .001 |
| Nonverbal working memory | r = .51, p = .029 |

**Table 3.**
**Correlates of switching and clustering**

| | Number of switches | Number of clusters |
|---|---|---|
| Verbal fluency total score | r = .81, p < .001 | r = .85, p < .001 |
| Fluid reasoning | r = .51, p = .027 | - |
| Verbal working memory | r = .56, p = .012 | - |

## SUMMARY

**Associations between verbal fluency and receptive vocabulary:**
- Receptive vocabulary was moderately correlated with verbal fluency total correct, an association which has also been described for children with DS [2] and young adults without DS [1]

**Associations between verbal fluency and executive functioning skills:**
- Executive functioning measures were moderately to strongly correlated with verbal fluency total correct, associations which have also been described for adults without DS [1]
- Both verbal and nonverbal working memory were associated with verbal fluency total correct, enabling the separation of effects of language from working memory as recommended by previous research in young adults without DS [1]
- Contrary to previous research [3], verbal short-term memory was not associated with verbal fluency total correct for young adults with DS in the current study

**Associations between verbal fluency strategies (clustering and switching) and receptive vocabulary and executive functioning skills:**
- Number of switches was associated with verbal fluency total correct, an association which has also been described for children with DS [2]
- Number of clusters was also associated with verbal fluency total correct for the young adults with DS, which extends the evidence base for young adults with DS [3]
- Cluster size was not associated with verbal fluency total score as has been described for adults with DS [3]
- Clustering and switching were not associated with receptive vocabulary, differing from previous research identifying an association between receptive vocabulary and clustering for children with DS [2]
- Instead, for the young adults with DS, fluid reasoning and verbal working memory were related to number of switches

**Clinical takeaways:**
- Verbal fluency results should be interpreted within the context of a comprehensive evaluation of language and executive functioning when making recommendations for daily living supports
- Determining verbal fluency strategies related to executive functioning may have important implications for driving intervention (e.g., examining whether accommodations like graphic organizers could help leverage use of switching to improve verbal fluency performance)
- Future research should include larger groups of individuals with DS to increase generalizability of findings

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