

# A User Guide to the Pediatric Versions of the Vanderbilt Fatigue Scale (VFS-Peds)©

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## 1. Rationale for the VFS

For some children the simple act of trying to listen and understand family, friends, and teachers can require substantial effort, especially in noisy conditions. When this effort is sustained over time it can lead to feelings of significant listening-related fatigue.<sup>1, 2, 3, 4</sup> Given that the mental effort needed for active listening is often increased in adults and children with hearing loss, this population may be particularly susceptible to listening-related fatigue. Mounting evidence suggests that severe fatigue can have negative psychosocial and academic effects<sup>5,6,7,8,9,10,11</sup> this evidence provided the motivation for the creation of the Vanderbilt Fatigue Scales (VFSs) described here. These tools were specifically designed to assess listening-related fatigue. While this manual focuses on the pediatric versions of the VFSs, adult versions are also available. Additional information and copies of the pediatric and adult versions of VFSs can be found at the VFS website (<https://www.vumc.org/vfs>).

## 2. Introduction to the VFS-Peds

There are **three** (3) versions of the Vanderbilt Fatigue Scale designed to assess listening-related fatigue in **school-age children (VFS-Peds)— child self-report (VFS-C), parent proxy-report (VFS-P), and teacher proxy-report (VFS-T)**.<sup>12</sup> More information about each version is found in the following sections. While the scales were originally developed to target fatigue in children who are deaf/hard of hearing (DHH), they may potentially be useful for other populations of children. For example, while evidence is limited, any child who may need to exert substantial mental effort when listening and/or processing auditory information (e.g., children with language disorders, non-native speakers, second language learners, children with auditory processing disorders/difficulties, or any learning difficulties) may be expected to struggle with listening-related fatigue.<sup>13</sup>

The VFS-Peds are designed to assess “long-term” listening-related fatigue, not the fatigue a child is feeling “right now”. Thus, the respondent is instructed to reflect on the past **WEEK** (or a typical week if the past week has been very unusual) and choose the response option that best describes how often they (or the child/student for parent or teacher proxy reports) have felt or acted during that time period. Response options for all scales utilize a 5-point (0-4) Likert frequency response scale. Response options include: Never (0), Rarely (1), Sometimes (2), Often (3), and Almost Always (4). The respondent should select a single response category (e.g., Never (0), Sometimes (2), etc.). An “in-between” response cannot be scored. Those administering the scales should ensure that a response is provided for all scale items.

### **The VFS-C: child self-report version**

The VFS-C is a **unidimensional** scale designed to assess listening-related fatigue in children **ages 6-17 years**. This self-report measure quantifies listening-related fatigue from the child's own perspective. The VFS-C is comprised of **10 test items**. Although the VFS-C was developed to be used with children as young as 6 years of age, our clinical experience suggests **the VFS-C is best suited for children aged 11-17 years**. Should the test be used with younger children, different test administration methods are recommended for children ages 6-10 versus those ages 11-17 (see Administration section on pages 4-5).

### **The VFS-P: Parent proxy-report version**

The VFS-P is a **multidimensional** scale designed to assess the physical and mental (social/emotional and cognitive) domains of listening-related fatigue in children **ages 6-17 years** via proxy-report from the child's parent/guardian. For more information about the multidimensionality of this scale, see Hornsby et al., 2022. The VFS-P is comprised of **12 items**. Seven items assess mental aspects of listening-related fatigue (i.e., cognitive, social, and emotional factors) and five items assess physical aspects of listening-related fatigue.

### **The VFS-T: Teacher proxy-report version**

The VFS-T is a **unidimensional** scale designed to assess listening-related fatigue in children **ages 6-17 years** proxy-report by the child's teacher\*. The VFS-T is comprised of **8 test items**.

\*Note, the VFS-T should be completed **only** by professionals with **direct knowledge** of the child's typical classroom behaviors and function. In most cases, this will be the child's primary classroom teacher. Specialists, such as deaf educators, educational audiologists, and speech-language pathologists can distribute the VFS-T to classroom teachers and utilize the findings as part of their assessment test battery.

## **3. Development of the VFS-Peds**

The VFS-Peds were developed following best practices for item and test development, test assessment, and test validation.<sup>12</sup> Results from Hornsby and colleagues (2022) revealed the scales are valid and sensitive to variations in listening-related fatigue across a wide range of fatigue severity levels. In addition, all scales have good reliability and test-retest stability. For example, acceptable test-retest stability will likely vary based on multiple factors (e.g., the construct being measured, the reliability of the test and the duration between testing points); however, reliability based on intraclass correlation coefficients (ICCs) is considered excellent for ICCs >.75 and fair to good for ICCs ranging from .40-.75.<sup>14</sup> Using these guidelines, test-retest reliability for all VFS-Peds scales was good to excellent. ICCs were .72, .84 and .84/.90 for the VFS-T, the VFS-C, and the VFS-P physical and mental subscales, respectively.

## 4. Administration of the VFS-Peds

The VFS-Peds were designed for English-speaking individuals; therefore, caution should be observed when attempting to use the scale with individuals who are not proficient at understanding or speaking English. All versions of the VFS-Peds can be administered in person. Remote administration (e.g., via mail, email, or online distribution) may be appropriate for some older children and adults (see below for details). Regardless, administration should be completed in a quiet, private, environment. If the respondent utilizes hearing technology (e.g., hearing aids, cochlear implants), the devices should be worn and functioning properly when providing instructions or during oral administration of the scales.

### **In-Person Administration:**

**Children ages 6-10 years:** For children in this age range the examiner should read aloud all VFS-C directions and items, verbatim. Depending on the child's abilities, the child may record their response independently or the examiner may record the child's response to each scale item.

**Children ages 11-17 years:** For children in this age range the examiner should first offer to read all VFS-C directions and items (e.g., "I can read the items to you if you wish. Would you like for me to read the test to you?"). If the child denies the offer of help and is able to adequately read and understand the items, the child may complete the VFS-C independently.

- Regardless of whether the child needs, or accepts, help completing the VFS-C, the examiner should ensure that the child is thoroughly reading and understanding the items (e.g., not answering "sometimes" for all questions without thoughtful consideration of their response). In such cases the examiner may offer again to read the questions aloud if the child does not appear to understand the directions or an item.
- Likewise, if there are any concerns regarding the respondent's ability to independently read and understand the test directions or any test item, the examiner should read all directions and items, verbatim, to the child.
- The examiner should discontinue administration if the examiner is concerned that the child may not be providing reliable responses (e.g., the child does not appear to understand the task, the scale instructions, or the scale items, or is not cooperative).

**Adults (Parents or Teachers):** Most adults can complete the scale independently. However, if there are any concerns regarding the respondent's ability to independently read and understand the test directions or any test item, the examiner should read all directions and items, verbatim, to the respondent.

**Follow-up "interview" questioning (All scales):** Whenever a respondent selects "Often" or "Almost Always" to a scale item (regardless of the scale), the test administrator should conduct follow-up questioning. The goal of the follow-up questioning is to assess the functional impact of the child's fatigue-related issue(s) and, if warranted, identify appropriate targets for

counseling or intervention. See “Follow-up interview process for “Often” or “Almost Always” responses” (Section 6, p. 8) for a description of the follow-up process.

**Online Administration:** It is optimal to administer the scale in person as this allows the test administrator to be available to read the test instructions and scale items aloud and to provide clarification, if needed, regarding the response process. However, the scales were developed and validated utilizing online and in-person data collection methods. Our experiences with this process suggest that parents, teachers, and children aged 11-17 years are able to reliably complete the scales via remote presentation (e.g., email or online). However, for younger children (6-10 years old), as noted above, the scale should be administered in person to allow the examiner to read aloud scale instructions and items.

## 5. Scoring the VFS-Peds

The VFS-Peds can be scored using two approaches.

**Summed Scoring:** All versions of the VFS-Peds can be scored by simply summing the item responses (0-4) across all scale, or subscale, items. **It is anticipated that clinicians will primarily utilize the summed scoring method.** The **VFS-C** and **VFS-T** are unidimensional measures thus summing all test items provides a total listening-related fatigue score. In contrast, the Parent Version (**VFS-P**) is a multidimensional measure of listening-related fatigue that provides physical and mental fatigue subscale scores. Subscale scores are obtained by summing the relevant items for each subscale (Mental Fatigue: items 1-7; Physical Fatigue: items 8-12).

Across all scales, *higher* summed scores indicate *more* frequent problems with listening-related fatigue. Given that each scale has a different number of test items, the maximum summed score varies across scales (see Table 1). Thus, summed scores should be compared to the scale specific standardization samples (see Interpreting VFS-Peds Scores section).

A summed score CANNOT be calculated unless ALL test items are answered (i.e., there are no missing scores).

**Table 1.** Number of test items and range of possible total (or subscale) summed scores for each version of the VFS.

| VFS-Peds Version   | Number of items | Range of scores |
|--------------------|-----------------|-----------------|
| Child (VFS-C)      | 10              | 0-40            |
| Parent (VFS-P)     |                 |                 |
| • Mental Fatigue   | 7               | 0-28            |
| • Physical Fatigue | 5               | 0-20            |
| Teacher (VFS-T)    | 8               | 0-32            |

**IRT Scale Scoring:** IRT scale scores have distinct advantages compared to summed scores which may make them especially useful for research investigations. Most importantly, IRT scale scores provide a more precise estimate of an individual's listening-related fatigue. When calculating a summed score, every scale item is equally weighted in its contribution to the total, or subscale, score. This scoring approach ignores the fact that some scale items provide a more precise estimate of an individual's listening-related fatigue than others. In contrast, IRT scoring weights the response to each scale item based on the item's information and discrimination ability and thus provides a more precise estimate of a given individual's listening-related fatigue.<sup>12</sup> In addition, unlike summed scoring, IRT scores can be estimated even if responses to 1-2 items are missing.

IRT scale scores are similar to standardized scaled scores, such as z-scores. **For the VFS, an IRT scale score of 0 reflects the mean magnitude of listening-related fatigue across, in theory, all respondents in the population. Thus, IRT scores of -3 and +3 would suggest very low and very high ratings of listening-related fatigue, respectively.**

Given the potential increased sensitivity of an IRT scoring method, researchers may find this approach particularly useful. As noted above, to calculate IRT scale scores requires the use of statistical software capable of IRT analysis. Our laboratory has developed custom software for this purpose (using R-statistical software<sup>15</sup>) which may be of interest to researchers. It is available for free download on our [website](#).

## **6. Interpreting VFS-Peds Scores**

As noted above, the VFS-Peds use a 5-point Likert response format to ascertain the frequency of listening-related fatigue problems a child experiences. Response options range from 0 (meaning the child never has these problems) to 4 (meaning the child almost always has these problems). Scores of 1, 2 or 3 indicate the child experiences the specific situation rarely, sometimes, or often, respectively. Thus, higher summed scores suggest the child is experiencing more frequent problems with listening-related fatigue.

For example, given that the VFS-C has 10 items, a child with a summed score  $\leq 10$  (i.e., a score of 0-10) means the child reported that problems with listening-related fatigue may occur sometimes but they were relatively rare or, with a score of 0, they never occurred. In contrast, a score  $\geq 30$  (i.e., a score of 30-40) means the child reported multiple problems with listening-related fatigue that occur often or almost always. Clearly, for this high-scoring child, problems with listening-related fatigue are a common occurrence and could impact the child's academic and psychosocial wellbeing. Research in adults has shown that complaints of such frequent fatigue-related issues are quite rare in individuals without hearing loss<sup>16</sup>. Thus, we contend that children (and adults) who are experiencing fatigue-related problems "often" or "almost always" during a typical week warrant additional follow-up. This concept is important for clinicians to keep this in mind when administering and interpreting the VFS-Peds.

**VFS-Peds Interpretation Guidelines:**

To interpret VFS-Peds responses clinicians should compare the individual’s responses to responses based on our standardization samples (i.e., children without hearing loss or other disabilities and their proxy-reporters; see Table 3 and Appendix A) and follow-up on any items which the child rates as occurring “Often” or “Almost Always”. Specifically, clinicians should:

- 1) Determine if the number of “Often” or “Almost Always” responses made by the individual, collapsed across all test items, exceeds our cutoff criterion of 3 or more responses in this range (See Table 3).
- 2) Determine if the individuals total summed score (VFS-C and VFS-T) or subscale scores (VFS-P) exceed the 1 standard deviation cutoff derived from our standardization samples (See Table 3).
- 3) Conduct follow-up “interview” questioning whenever a respondent selects “Often” or “Almost Always” to **ANY** scale item. The goal of the follow-up questioning is to assess the functional impact of the child’s fatigue-related issue(s) and, if warranted, identify appropriate targets for counseling or intervention. A description of the follow-up “interview” process is provided below.

**Interpretation based on a standardization sample:**

To identify children who may need additional follow-up we examined the distribution of VFS-Peds scores from control groups of typically developing children aged 6-17 years. Typically developing was defined as children without hearing loss or any other parent-reported disability based on the report of the child’s parent (VFS-C and VFS-P) or the school professional (VFS-T). Control group data were gathered from a convenience sample of typically developing children (N=120), from parents who reported on their typically developing children (N=158), and from teachers who reported on typically developing students (N=68). Demographic data on this sample is shown in Table 2.

**TABLE 2.** Demographics of children as reported by control group samples.

|  | <b>Child</b>      | <b>Parent</b>     | <b>School Professional</b> |
|--|-------------------|-------------------|----------------------------|
| Number of children reported on           | N=120             | N=151             | N=68                       |
| Child Age (mean/median & range in years) | 13.2/13<br>(9-17) | 11.2/11<br>(6-17) | 10.2/9<br>(6-17)           |
| Child Grade (mean/median & range)        | 7.9/8<br>(3-12)   | 6.3/7<br>(K-12)   | 6.4/4<br>(*K-12)           |
| Gender (Number & Percentage of sample)   |                   |                   |                            |
| Male                                     | 57 (47.5%)        | 79 (52.3%)        | 36 (53%)                   |
| Female                                   | 63 (52.5%)        | 71 (47%)          | 27 (40%)                   |
| Did not disclose                         | 0 (0%)            | 1 (0.7%)          | 5 (7%)                     |

\*K= Kindergarten

These data were derived from summed scores for each participant and were used a) to generate percentile ranks for all VFS-Peds child and teacher scale scores and parent subscale

scores and b) to identify cutoff scores for identifying children whose fatigue may warrant additional follow-up, monitoring, or intervention. To generate these data, a best-fit to the distribution of summed scores for each standardization sample was determined using IBM SPSS Statistics for Windows, Version 23.0. The best-fit curves were then used to calculate percentile ranks for a given score. This approach also allowed for the imputation of the number of respondents for any summed scores that were not present in a data set, enabling percentile ranks to be calculated for the entire range of scores covered by each scale (See Appendix A).

Using the data from our standardization samples we determined cutoff criterion for each version of the VFS-Peds. These cutoff criteria may be useful for identifying children with significant reports of listening-related fatigue. Cutoff values were determined in two ways.

First, consistent with our assumption that fatigue-related issues that occur “Often” or “Almost Always” are of particular concern, we compared the frequency of occurrence of “Often” or “Almost Always” responses between our child, parent, and school professional standardization samples to responses from children with hearing loss (VFS-C), parents of children with hearing loss (VFS-P), and professionals working with children with hearing loss (VFS-T) who had completed the scales during the validation phase of the VFS-Peds development (See Hornsby, et al., 2022 for details of these hearing loss groups<sup>15</sup>). Using these data, we determined that respondents who selected **3 or more** “Often” or “Almost Always” responses were significantly different, at a probability level of .8 ( $p < .2$ ), from the standardization sample groups. We chose to utilize a more liberal cutoff of  $p=.2$  (instead of .05) because there was substantial overlap in the distribution of summed scores from our typically developing and hearing loss samples. For the VFS-P we chose to use a cutoff criterion based on the total number of Often or Almost Always responses across the Physical and Mental subscales, rather than using subscale specific criterion. We felt this less conservative guideline was appropriate given our underlying assumption that frequent fatigue-related issues (regardless of the subscale) are of concern.

Second, we calculated cutoff criterion using values of  **$\geq$  one standard deviation** above the mean of the standardization sample for a given VFS-Peds scale. We chose to use a less conservative criterion of one standard deviation rather than a higher value (e.g., 2 standard deviations) due to the substantial overlap in summed scores between our standardization samples and hearing loss groups. It is worth noting that across all VFS-Peds scales, children with scores exceeding the cutoff criteria of  $\geq$  one standard deviation above the standardization sample means (See Table 3) are reporting that many of their listening-related fatigue problems are occurring “Often” or “Almost Always” and would thus warrant additional follow up or monitoring.

Comparing a respondent’s VFS score to the standardization sample allows clinicians to determine where their patient’s fatigue falls relative to a control sample of typically developing children. Table 3 shows the cutoff criterion used for each version of the VFS-Peds to identify children for follow-up counseling and, if warranted, intervention.

**Table 3.** Cutoff criterion based on VFS-Peds standardization sample responses.

| VFS-Peds Scale               | Cutoff Criterion*                   |                                 |
|------------------------------|-------------------------------------|---------------------------------|
|                              | # of Often/ Almost Always Responses | Summed scores $\geq 1$ st. dev. |
| VFS-C (Child Self-report)    | $\geq 3$                            | 27                              |
| VFS-T (Teacher Proxy-report) | $\geq 3$                            | 23                              |
| VFS-P (Parent Proxy-report)  | $\geq 3$                            | NA                              |
| • Mental fatigue             | NA                                  | 15                              |
| • Physical fatigue           | NA                                  | 13                              |

**\*Selecting  $\geq 3$  “Often” or “Almost Always” responses or having a summed score that is  $\geq 1$  standard deviation above standardization sample means that problems with listening-related fatigue are common and may impact the child’s academic and psychosocial function. Thus, additional follow-up is warranted.**

**Appendix A** provides percentile ranks for each summed score for the child, teacher, and parent versions of the VFS-Peds. Future research which included the development of a large scale, systematic, normative sample would augment the data herein that are based upon convenience sampling.

**Follow-up interview process for “Often” or “Almost Always” responses:**

Following our assumption that experiencing fatigue-related issues “Often” or “Almost Always” is a cause for concern, we recommend follow-up questions whenever a respondent selects “Often” or “Almost Always” to **ANY** scale item. The goal of the follow-up questioning is to assess the functional impact of the child’s fatigue-related issue(s) and, if warranted, identify appropriate targets for counseling or intervention.

For example, when completing the VFS-C assume a child selected only two “Often” or “Almost Always” items (one each, all other items were lower ratings) and had a summed score of 19. Such scores do not exceed the cutoff criterion listed in Table 3 (i.e.,  $\geq 3$  Often or Almost Always responses or VFS-C summed score  $\geq 27$ ). Despite this we recommend conducting follow-up questioning in response to ANY “Often” and “Almost Always” responses. In this example assume the child selected “Often” in response to the item “I feel worn out when I have to listen carefully” and they selected “Almost Always” in response to the item “I give up trying to listen when I get tired.” Behaviors such as “giving up trying to listen” could have significant impact on the child in a school setting. This is especially of concern given the child reports that they “often” feel worn out when they must listen carefully.

To assess the functional impact of the child’s fatigue-related issue(s), we recommend you ask follow-up questions to identify when, where, and how the child experiences the fatigue. For example, in this case you could query the child: “You said you often feel worn out when you have to listen carefully. Can you give me some examples of where you are and what you are doing when this happens to you?” Other follow-up questions might include: “Are there certain activities or times at school when you feel like you often give up listening? What does it look

like when you give up trying to listen? What do you do instead?" The goal here would be to identify specific settings or situations that are potentially problematic and may be appropriate targets for counseling or intervention. This kind of specific information can be communicated, along with the results of the VFS itself, to school professionals and/or IEP team members working with the child to help guide their planning for the child.

## **7. Accessing the VFS-Peds**

All versions of the VFS-Peds are copyrighted and may not be rented, leased, sold, sub-licensed, or distributed for commercial purposes. Those interested in using the scale for personal, educational, research, or clinical purposes can access all scales from their original publications (see reference list) or from the [VFS website](#).

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## Appendix

Appendix A. Percentile ranks for summed scores for each VFS-Peds scale. Percentile ranks are based on best-fits to the control group summed score distributions. See text for details.

| Percentile Ranks of VFS-Peds Control Groups |       |             |                   |             |                   |             |         |
|---|-------|-------------|-------------------|-------------|-------------------|-------------|---------|
| VFS-C Score                                 | Child | VFS-P Score | Parent (Mental)   | VFS-P Score | Parent (Physical) | VFS-T Score | Teacher |
| 0   | 99.2  | 0           | 89.5 <sup>§</sup> | 0           | 98                | 0           | 95.6    |
| 1   | 96.1  | 1           | 79.3              | 1           | 95.2              | 1           | 93.3    |
| 2   | 92.9  | 2           | 71.1              | 2           | 89.8              | 2           | 92      |
| 3   | 91.6  | 3           | 67.1              | 3           | 87.8              | 3           | 90.7    |
| 4   | 89    | 4           | 63.2              | 4           | 85.7              | 4           | 89.3    |
| 5   | 86.6  | 5           | 62.5              | 5           | 78.2              | 5           | 85.3    |
| 6   | 84.3  | 6           | 57.2              | 6           | 74.1              | 6           | 82.7    |
| 7   | 81.9  | 7           | 49.3              | 7           | 68                | 7           | 81.3    |
| 8   | 78.7  | 8           | 45.4              | 8           | 55.8              | 8           | 84.7    |
| 9   | 72.4  | 9           | 38.8              | 9           | 44.2              | 9           | 80.7    |
| 10  | 70.1  | 10          | 34.9              | 10          | 40.1              | 10          | 78      |
| 11  | 64.9  | 11          | 32.9              | 11          | 30.6              | 11          | 64      |
| 12  | 65.4  | 12          | 27                | 12          | 21.4              | 12          | 58.7    |
| 13  | 61.4  | 13          | 23                | 13*         | 15.0              | 13          | 53.3    |
| 14  | 55.9  | 14          | 19.1              | 14          | 10.9              | 14          | 52      |
| 15  | 51.2  | 15*         | 15.2              | 15          | 6.8               | 15          | 49.3    |
| 16  | 48    | 16          | 13.8              | 16          | 4.8               | 16          | 45.3    |
| 17  | 45.7  | 17          | 11.8              | 17          | 4.1               | 17          | 42.7    |
| 18  | 40.2  | 18          | 8.6               | 18          | 2.0               | 18          | 33.7    |
| 19  | 37    | 19          | 7.2               | 19          | 0.7               | 19          | 30.7    |
| 20  | 33.1  | 20          | 6.6               | 20          | 0.01              | 20          | 26.7    |
| 21  | 30.7  | 21          | 5.9               | --          | --                | 21          | 22.7    |
| 22  | 27.6  | 22          | 3.9               | --          | --                | 22          | 17.3    |
| 23  | 25.2  | 23          | 3.3               | --          | --                | 23*         | 16.0    |
| 24  | 22.8  | 24          | 2.6               | --          | --                | 24          | 13.3    |
| 25  | 19.7  | 25          | 2.0               | --          | --                | 25          | 12      |
| 26  | 17.3  | 26          | 1.3               | --          | --                | 26          | 9.3     |
| 27*   | 15.7  | 27          | 0.7               | --          | --                | 27          | 8       |
| 28  | 15    | 28          | 0.01              | --          | --                | 28          | 6.7     |
| 29  | 14.2  | --          | --                | --          | --                | 29          | 5.3     |
| 30  | 12.6  | --          | --                | --          | --                | 30          | 4       |
| 31  | 11    | --          | --                | --          | --                | 31          | 2.7     |
| 32  | 7.9   | --          | --                | --          | --                | 32          | 0.01    |
| 33  | 7.1   | --          | --                | --          | --                | --          | --      |
| 34  | 4.7   | --          | --                | --          | --                | --          | --      |
| 35  | 3.9   | --          | --                | --          | --                | --          | --      |
| 36  | 3.1   | --          | --                | --          | --                | --          | --      |
| 37  | 2.4   | --          | --                | --          | --                | --          | --      |
| 38  | 0.6   | --          | --                | --          | --                | --          | --      |
| 39  | 0.8   | --          | --                | --          | --                | --          | --      |
| 40  | 0.01  | --          | --                | --          | --                | --          | --      |

\*One standard deviation above the mean cut-off score

<sup>§</sup>Because the Parent (Mental fatigue) normative distribution is skewed, a score of 0 includes all percentile ranks between 89.5 through 99.9.