The Complexities of Fatigue in Children with Hearing Loss

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Abstract

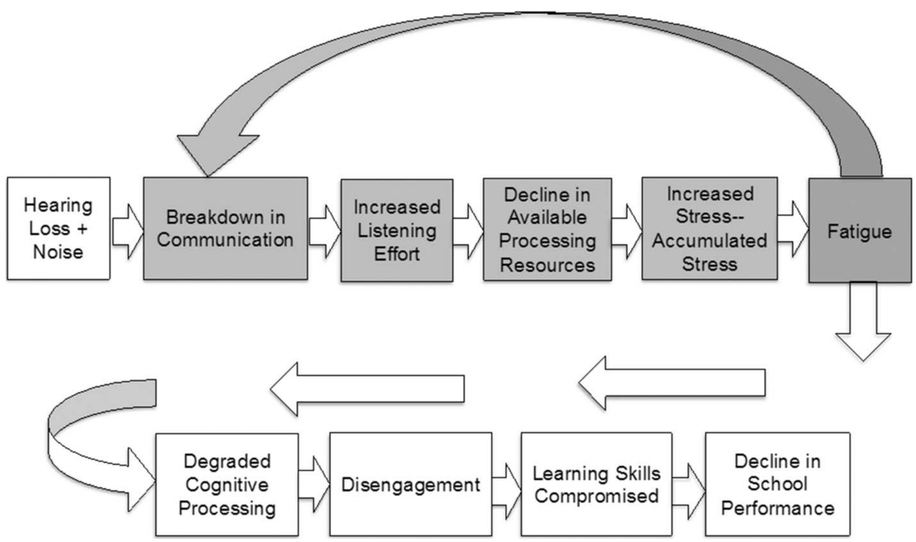
Fatigue is a common phenomenon in our society, and it can have a major impact on an individual's performance and wellbeing. Parents and teachers have long believed that children with hearing loss (CHL) are at increased risk for fatigue. One could easily speculate that toward the end of a school day, CHL may be "physically and mentally spent" as a result of focusing so intently on a teacher's speech, as well as conversations with other students. Moreover, the increased listening effort, stress, and subsequent fatigue experienced by CHL could jeopardize the ability to learn in a noisy classroom environment, thus increasing the risk for problems in school. Only recently, however, have we begun to see empirical studies supporting the notion that CHL experience more fatigue than children with normal hearing (CNH).

This review was developed to enhance the awareness of fatigue among those audiologists interested in serving CHL. To this end, we have presented an overview on fatigue in CHL, including its importance, definitions, prevalence, consequences, and recent developments. The complexity and multifaceted nature of fatigue has been highlighted and the need for additional research on fatigue in CHL is emphasized.

It has long been recognized that fatigue, resulting from sustained listening demands, is a significant concern for working adults with hearing loss. The additional attention, concentration, and effort needed to overcome the communicative problems associated with hearing loss results in increased reports of listening effort, stress, and fatigue compared to adults with normal hearing (Hétu, Riverin, Lalande, Getty, & St-Cyr, 1988; Hornsby, 2013). The fatigue associated with these sustained listening-demands has a significant negative impact on work performance and quality of life (Kramer, Kapteyn, & Houtgast, 2006; Nachtegaal et al., 2009). Children with hearing loss (CHL) may also be physically and mentally tired as a result of focusing so intently on a teacher's speech, as well as the conversations of other children. Pilot studies and reports from teachers and parents of CHL support the belief that CHL seem to be at increased risk for stress and fatigue (Hicks & Tharpe, 2002; Noon, 2013; M. Ross, personal communication, August 13, 2012). Only recently, however, have experimental studies begun to offer support to this longstanding premise (Gagne, Alepins, & Dubois, 2010; Gustafson, Delong, Werfel, & Bess, 2013; Hicks & Tharpe, 2002; Hornsby, Werfel, Camarata, & Bess, 2014; McFadden & Pittman, 2008; Pittman, 2011a; Rentmeester, Shuster, Hornsby, & Bess, 2013). In addition to the inherent disadvantage of reduced access to auditory information resulting from hearing loss, the increased listening effort, stress, and subsequent fatigue could compromise their facility to learn in a noisy classroom environment, thus increasing the risk for learning problems in school. Is it really that difficult for CHL to listen, process speech, attend, and learn in the school environment? We believe that it is—at least for a portion of school-age CHL. A simplified conceptual model linking CHL to listening effort, stress, fatigue, and school performance is shown in Figure 1. CHL wearing hearing aids, implants, and/or assistive devices in noisy/reverberant classroom conditions experience breakdowns in communication especially in the area of speech understanding—the more noise and reverberation in the classroom the more difficult speech understanding becomes. This breakdown in speech understanding brings about increased listening effort, which, in turn, results in a reduction in available processing capacity that might otherwise be used for other purposes, such as memory recall. Even if the speech signal is made sufficiently loud and clear to afford correct identification, CHL have to invest more cognitive resources to detect, process, and understand speech than normal hearers—a concept sometimes referred to as the *effortfulness hypothesis* (Gagne et al., 2010; Hicks & Tharpe, 2002; Howard, Munro & Plack, 2010; McCoy et al., 2005; Rabbitt, 1966, 1968, 1991). In this conceptual model, the process (shaded area in Figure 1) occurs repeatedly throughout the day, resulting in increased listening effort, accumulated stress, and fatigue. Eventually, a tipping point is reached. That is, the collective listening effort, accumulated stress, and fatigue are no longer manageable and the child's cognitive processing begins to falter. The continued effort to keep up may be replaced by a strategy of low engagement (Hockey, 2013). Stated otherwise, the child essentially gives up—and the combination of effort, stress, hearing-related fatigue, degraded cognitive processing, and/or disengagement impacts negatively on the behavioral skills essential for learning in school.

An adult with hearing loss described their own fatigue using a sequence of events somewhat similar to that depicted in Figure 1. "When you are hard of hearing you struggle to hear; when you struggle to hear you get tired; when you get tired you get frustrated; when you get frustrated you get bored; when you get bored you quit," (Pichora-Fuller, 2003).

Figure 1. Conceptual Model Linking Hearing Loss to Fatigue and School Performance. Shaded areas represent events that occur repeatedly throughout the school day.



Given such a testimony, it is not surprising to learn that fatigue does indeed impair human performance in both adults and school-age children (Dinges et al., 1997; Gaba & Howard, 2002; Hockenberry-Eaton et al., 1999; Kramer et al., 2006; Ravid, Afek, Suraiya, Shahar, & Pillar, 2009a; Van Dongen & Dinges, 2000). Interviews and survey data reveal that adults with hearing loss experience more stress and fatigue in the workplace than normal hearing workers—and such stress and fatigue negatively impacts work performance (Bess & Hornsby, 2014; Kramer et al., 2006; Morata et al., 2005). The finding that some CHL are at increased risk for fatigue has important educational implications. Evidence from children with other chronic conditions suggests that recurrent and untreated fatigue is associated with increased school absences, reduced academic performance, an inability to engage in usual daily activities, sleep disturbances, and a negative change in life quality (Beebe, 2011; Berrin et al., 2007; Bess & Hornsby, 2014; Crawley, Emond, & Sterne, 2011; Crawley et al., 2012; Garralda & Rangel, 2002; McCabe, 2009; Ravid, Afek, Suraiya et al., 2009a, b; Stoff, Bacon, & White, 1989).

Summarizing to this point, we find that some CHL may be at increased risk for fatigue and such fatigue can potentially compromise one's ability to learn in school. Despite its pronounced importance, little is known about fatigue in CHL; and, empirical evidence in this area is sparse. What follows, is a general overview of fatigue in CHL—we discuss definitions, prevalence, and consequences of fatigue. We also briefly examine recent developments associated with fatigue in CHL and offer suggestions regarding the identification and management of fatigue in school-age children. Finally, we conclude with a few comments on future directions.

Understanding the Construct of Fatigue

Fatigue has a pervasive influence on our lives and is experienced by everyone at one time or another. In fact, fatigue is one of the most common complaints heard in primary care settings and is a prominent symptom associated with numerous chronic health conditions (Wessely, Hotoph, & Sharpe, 1998). Yet, we find that fatigue in today's society is seldom studied and is poorly understood. Hockey (2012) commented that "after more than 100 years of research on fatigue we do not really know much about it [. . .] and there is still no mature theory of its origins and functions" (p. 45). It seems as if we have more questions than answers. Why is it that we sometimes feel tired when we haven't really done anything (Hockey, 2013)? Why is it that a given activity results in more fatigue than another activity which seems to require more energy resources? How is fatigue related to such entities as energy level, listening effort, and stress? What are the causes of fatigue, especially unexplained fatigue that occurs in the absence of a medical diagnosis? Why is it that a child with hearing loss is at increased risk for fatigue, whereas another child with similar hearing loss and case history has no problem with fatigue? These questions, and so many others, highlight the fact that fatigue, though ubiquitous and a major health problem in our society, is indeed multifaceted and complicated (Bess & Hornsby, 2014; Hockey, 2013; McGarrigle et al., 2014).

Definition and Prevalence of Fatigue

Fatigue is often described as a general sense of tiredness and weariness (Thomas, 1993). Although this description accurately portrays the subjective feelings of many individuals who are fatigued, it underplays the complexity and multifaceted nature of fatigue. Fatigue is a complex subjective symptom with physical and mental/cognitive dimensions. The definition of fatigue varies depending on the person describing the construct (e.g., layperson, psychologist, physician), the context in which fatigue is described (e.g., muscle fatigue in athletes, cognitive fatigue in multiple sclerosis), and whether the fatigue is part of a medical illness (chronic health condition) or occurs in the absence of a medical diagnosis (nonclinical or unexplained fatigue; Bess & Hornsby, 2014). In fact, a universally accepted or standardized definition of fatigue does not exist. Physical fatigue refers to a reduced ability or desire to perform some physical task (Chalder et al., 1993; Dimeo et al., 1997), whereas mental/cognitive fatigue may be defined subjectively as a mood state —a feeling of tiredness, exhaustion, or lack of energy due to cognitive or emotional—as opposed to physical—demands. In some cases, the subjective experience of fatigue may be accompanied by a decrease in physical or cognitive processing abilities. Thus, cognitive fatigue has also been described as a state of decreased optimal performance due to sustained cognitive demands. Cognitive fatigue is characterized by difficulties in concentration, increased distractibility, feelings of anxiety, reduced attentiveness or alertness, and decreases in mental energy or efficiency (Boksem & Tops, 2008; Lieberman, 2007).

Recall that fatigue is very common in our society. In fact, the number one complaint on health-related websites is fatigue, tiredness or the absence of energy (Lieberman, 2007). In general, we find that prevalence rates vary depending on how fatigue is defined and the characteristics of the group assessed (e.g., age, gender, ethnicity and health status [chronic health conditions versus healthy populations]; Bess & Hornsby, 2014). For a community-based population, it is estimated that fatigue affects 18–38% of adults (van't Leven, Zielhuis, van der Meer, Verbeek, & Bleijenberg, 2009; Wessely et al., 1998). Fatigue is reportedly more common in females and in lower socio-economic groups (Wessely et al., 1998). In populations defined by chronic health conditions, the frequency and severity of fatigue among adults and children is much more common (e.g., pediatric cancer: >50% [Bottomley, Teegarden, & Hockenberry-Eaton, 1995]; type 1 diabetes: 40% [Goedendorp et al., 2014]; multiple sclerosis: 78% [Freal, Kraft, &Coryell, 1984]; systemic lupus erythematosus: >80% [Hastings, Joyce, Yarboro, Berkebile, & Yocum, 1986]).

How Does Energy, Listening Effort, and Stress Fit In?

Fatigued individuals often describe their condition as "having no energy." In fact, those who are unable to complete daily activities or are overwhelmed by such activities, frequently attribute this condition to a state of low energy or lack of energy. To most of us, mental energy is considered important for accomplishing daily tasks and for quality of life—it is viewed as a multidimensional concept that includes such constructs as mood, cognition, motivation, sleepiness and quality of life (Lieberman, 2007; O'Connor & Burrowes, 2006). Moods are subjective transient feelings. The mood of energy alludes to feelings regarding whether or not capacity exists to complete different activities (mental or physical). Two terms, vigor and vitality, are often used to describe energy as a mood state. A self-report questionnaire, the Profile of Mood States (POMS; McNair, Lorr & Droppleman, 1971), is considered an effective subjective tool for measuring mental energy (O'Conor, 2004).

The scientific literature on mental energy is limited. There is no consensus on the definition of mental energy, and the relationship between feelings of energy and fatigue are not well understood. Some researchers view energy and fatigue as opposites of the same construct, whereas others view these two entities as separate constructs (Lieberman, 2007).

Listening effort may be described as the exertion of mental energy needed to attend to and understand spoken messages (Hicks & Tharpe, 2002; McGarrigle et al., 2014). In a general sense, listening effort can be thought of as a specific type of mental effort. Mental effort in general has been studied with particular attention to the mental workload associated with human performance. This mental workload is thought of as a burden brought about by the person and/or the task. In addition, mental workload refers to the decisions humans make, along with the rate and the difficulty associated with making the decisions.

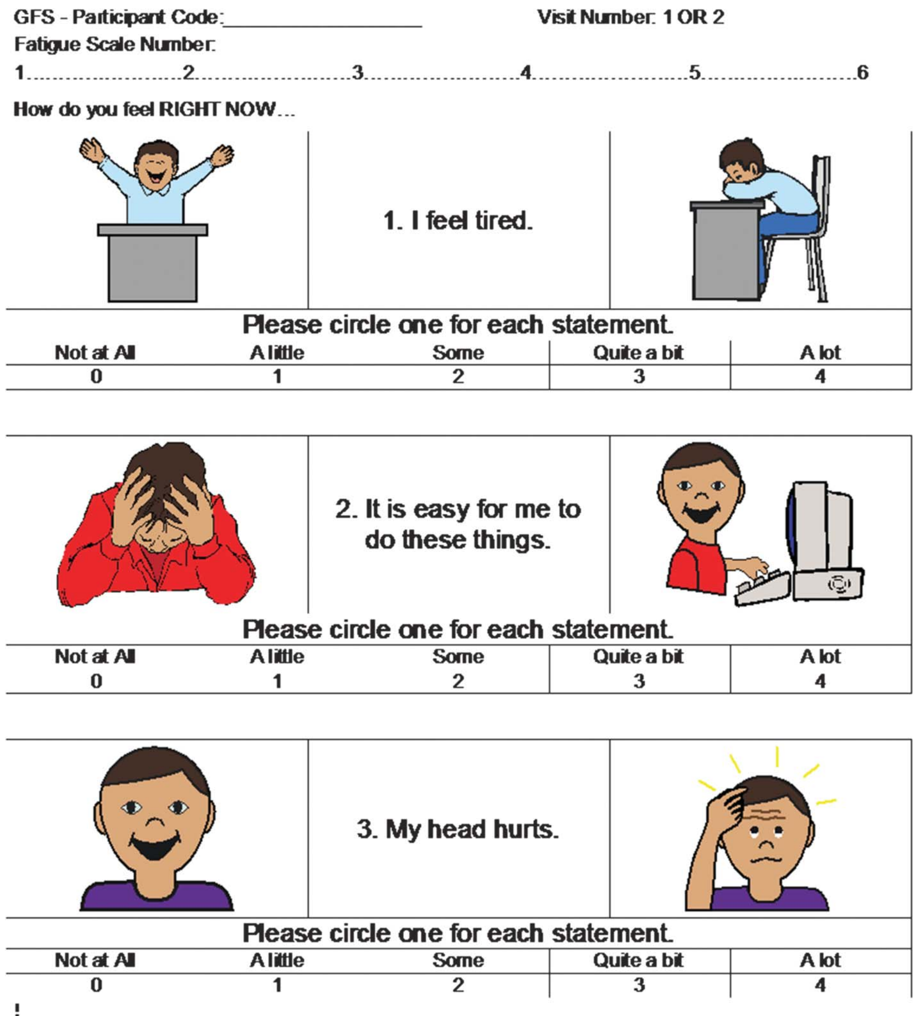
Children in classroom settings have many different mental workloads placed on them, with mental effort being required to complete many tasks. For example, mental effort is required to complete a written assignment, read a schoolbook, or listen to the teacher and to other children in the classroom. The magnitude of listening effort required in this situation can depend on many factors, from the students' cognitive and attention capabilities to classroom acoustics. Importantly, to offset deficits in audibility, children and adults with hearing loss must increase their mental effort compared to persons without hearing loss when attempting to detect, process and respond to auditory stimuli, such as speech (Hicks and Tharpe, 2002; McCoy et al., 2005). In addition to potential learning difficulties in CHL, it is generally assumed that increased listening effort is associated with subjective reports of fatigue in persons with hearing loss in everyday settings (e.g., Edwards, 2007; Zekveld et al. 2011). Anecdotal reports from individuals with hearing loss suggest a linkage between demanding speech processing in daily living and feelings of stress and fatigue (Bess & Hornsby, 2014).

Stress is defined as a state of mental or emotional strain or tension resulting from adverse or very demanding circumstances; adversity that is capable of disrupting an individual's normal state of being (Middlebrooks & Audage, 2008). Like listening effort and fatigue, stress is common in our everyday lives—some stress is actually helpful because it enables us to focus on a given task. Too much stress, however, serves as a disruption to performance, which, in turn, leads to feelings of fatigue, lack of energy, irritability, demoralization, and hostility (Hockey, 2013; McEwen, 1998). Moreover, stress is capable of affecting one's health by causing emotional distress and leading to a variety of physiological changes (increased heart rate, elevated blood pressure, rise in stress hormones; Middlebrooks & Audage, 2008). Hence, fatigue can be viewed as a direct outcome to the presence of sustained stress activity. Recently, Kocalevent, Hinz, Brahler, and Klapp (2011) described fatigue as "a stress-related disorder" (p. 241). We thus find that fatigue and stress are highly associated; and, these two entities often overlap (Kocalevent et al., 2011; Magbout-Juratli, Janisse, Schwartz, & Arnetz, 2010; Olson, 2007).

Recent Developments on Fatigue in CHL

As noted earlier, parents and teachers often report that CHL are at increased risk for fatigue. How did they arrive at such a conclusion? Primarily through anecdotal observation and listening to the children describe fatigue in their own words—about being tired, exhausted, wanting to take naps and about not wanting to participate in physical activities. In fact, the primary means to assess fatigue in children and adults is by subjective self-reporting. Numerous self-report questionnaires have been developed for both children and adults to assess cognitive fatigue and physical fatigue. Comprehensive reviews of subjective measures of fatigue can be found elsewhere and are beyond the scope of this paper (Christodoulou, 2007; McGarrigle et al., 2014;). Briefly, these tests are simple, cost-effective, easy to administer, and contain high face validity. These instruments can be used to identify the presence and severity of fatigue; they are also used to assess the effectiveness of intervention strategies on fatigue. Many fatigue scales are available for the adult population, however, very few such scales exist for CHL—and no such scales have been developed specific to hearing loss (Bess & Hornsby, 2014). A sample of a few fatigue scale items that could be used with children appears in Figure 2. These items are part of a five-item questionnaire developed by our research lab at Vanderbilt to subjectively assess hearing related fatigue following sustained and demanding listening tasks. Importantly, most fatigue scales contain multiple domains that represent such dimensions as physical fatigue, sleep/rest fatigue, and cognitive fatigue.

Figure 2. Example of Subjective Fatigue Scale Items Designed for Children.

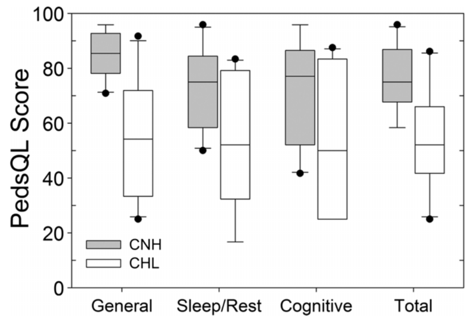


We are just now beginning to see studies on fatigue in CHL using subjective self-report measures. Perhaps one of the first studies to report on fatigue in CHL was Bess, Dodd-Murphy, & Parker (1998). They assessed functional health status in a group of school-age children with minimal hearing loss and children with normal hearing (CNH) using the COOP Adolescent Chart Method (Nelson, Wasson, Johnson, & Hays, 1996: Nelson et al., 1987; Wasson, Kairys, Nelson, Kalishman, & Baribeau, 1994). The COOP is a reliable and valid office-based screening tool for functional health. The tool is based on a five-point scale with five representing the greatest dysfunction. Bess and coworkers found that children with minimal hearing loss had significantly greater dysfunction than normal hearers on two subtests of the COOP related to fatigue—stress and energy. In contrast, Hicks and Tharpe (2002) used the same instrument but did not report differences between their CHL and an age-matched group of CNH. The inconsistencies between Bess et al. and Hicks and Tharpe may be due to differences in study participants such as, sample size (Bess et al. N=66; Hicks & Tharpe N=10), hearing aid use, and type of hearing loss (unilateral versus bilateral hearing loss). Another possibility is that the COOP, which is only a screening tool, lacks the needed sensitivity for detecting fatigue (Hornsby et al., 2014).

To date, only one study (Hornsby et al., 2014) has examined fatigue in school-age CHL using a standardized and validated self-report measure, the PedsQL Multidimensional Fatigue

Scale (PedsQL MFS; Varni, Burwinkle, Katz, Meeske, & Dickinson, 2002; Varni, Burwinkle, & Szer, 2004). The PedsQL consists of three different fatigue domains (cognitive fatigue, sleep/rest fatigue, and general fatigue); a total fatigue score can also be obtained from the three subscales. Hornsby and coworkers (2014) reported that school-age CHL experienced significantly more fatigue across all fatigue domains than an age-matched group of CNH (See Figure 3).

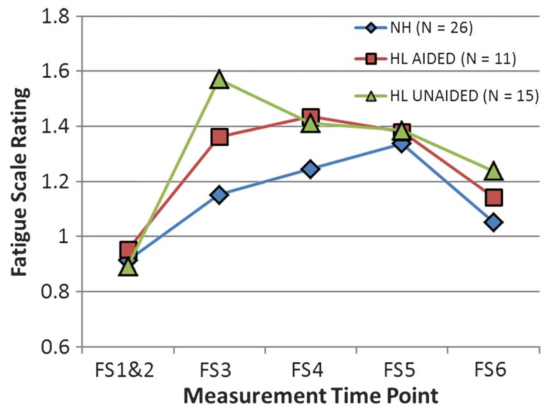
Figure 3. Box and Whisker Plot Showing PedsQL-MFS Ratings. Ratings from 10 CHL (white boxes; mean age =10;3 [years; months]; range: 6;3 – 12;9) and 10 CNH (grey boxes; mean age =10;2; range: 6;2 – 12;9). Lower values reflect more fatigue. Middle lines represent median fatigue ratings, boxes show 25th to 75th percentile range, whiskers indicate the 10th and 90th percentiles, filled circles represent individual data points above and below the 90th and 10th percentiles (Adapted from Hornsby, B.W.Y., Werfel, K., Camarata, S. & Bess, F.H. "Subjective fatigue in children with hearing loss: Some preliminary findings", American Journal of Audiology, December 23, 2013).



Surprisingly, CHL reported more fatigue on the PedsQL than children with other health conditions such as cancer, rheumatoid arthritis, diabetes, and obesity (Varni et al., 2002; Varni et al., 2004; Varni, Limbers, Bryant, & Wilson, 2009, 2010). It is noteworthy, that the PedsQl was not developed for CHL; hence, the scale does not include items specific to hearing loss. A scale that includes the voice of children with hearing loss and their parents might well produce even larger differences between CHL and CNH. Also important to note is the especially wide range of fatigue scores reported by CHL. Some children reported scores well within the range of CNH, whereas others reported substantially more fatigue. Clearly, additional work is needed to improve our understanding of factors that mediate and modulate fatigue in CHL.

An alternative approach to the assessment of subjective fatigue is to examine whether or not cognitively demanding and sustained listening tasks lead to increases in subjective fatigue over time. Rentmeester and colleagues (2013) demonstrated that subjective fatigue increases in CHL and CNH during prolonged and demanding listening tasks (2.5 to 3 hours) that are similar to a classroom environment. To monitor fatigue, a five-item questionnaire with a five-point rating scale was used (0: not at all fatigued, 4: very fatigued]. The fatigue questions included: (1) I feel tired; (2) It is easy for me to do these things; (3) My head hurts; (4) It's hard for me to pay attention; and (5) I have trouble thinking (See Figure 2 for example). The fatigue scale was administered six times over the course of the demanding listening tasks. A mean fatigue score was calculated by averaging responses across the five items (item 4 was reverse scored). Figure 4 illustrates mean fatigue scale ratings for CHL in aided and unaided conditions and CNH during the prolonged listening tasks. The ratings are based on the average rating across the five fatigue questions and are plotted as a function of measurement time point. Baseline scores were established by averaging ratings at time points 1 and 2 (FS 1&2) given the children were not yet required to complete demanding auditory tasks that involved sustained listening effort.

Figure 4. Fatigue Scale Ratings of CHL and CNH During a Series of Demanding and Prolonged Listening Tasks as a Function of Measurement Time Point (2.5–3 hours total).

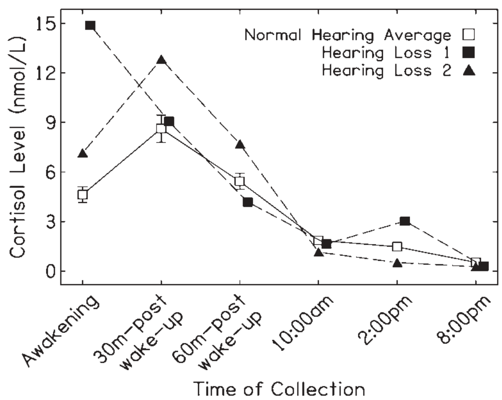


At time point 3 (FS3), however, fatigue score differences are clearly seen between CNH, CHL (wearing hearing aids), and CHL (unaided). The CHL (unaided) show the greatest amount of fatigue followed by CHL (aided). The CNH reported the least amount of fatigue following the prolonged listening tasks. Interestingly, at time points 5 and 6 (FS5, FS6) the differences between CHL and CNH lessen—such a finding is consistent with the idea that both CHL and CNH reached a tipping point. That is, the effort required to perform the sustained tasks is replaced by a strategy of low engagement.

Subjective fatigue scales have limitations—most importantly, they do not provide us with information about the potential mechanisms underlying the fatigue experience. Several different physiological measures have been advocated in recent years for assessing cognitive fatigue—some of these measures include event-related potentials (ERP; Murata, Uetake, &Takasawa, 2005), skin conductance (Segerstrom & Solberg Nes, 2007), functional magnetic resonance imaging (fMRI; Lim et al., 2010) and salivary cortisol levels (Hicks & Tharpe, 2002). To our knowledge, salivary cortisol is the only physiologic indices used, to date, to investigate fatigue in CHL—hence, cortisol will be the only physiologic approach discussed here. Those readers interested in a comprehensive review of physiological methods for measuring fatigue are referred to other available sources (DeLuca, 2005; Matthews, Desmond, Neubauer, & Hancock, 2012; McGarrigle et al., 2014).

Measuring salivary cortisol is a promising area of inquiry into the nature of stress, expenditure of energy, and associated fatigue. Cortisol measures are simple, noninvasive, easy to administer, and can be collected in a naturalistic environment such as a classroom or playground. Hence, this physiologic technique appears to be especially useful for children—even infants and toddlers are able to provide salivary cortisol samples suitable for lab analysis (Gunnar, 1992). Responding to a stressful event is one of the critical roles of the hypothalamic-pituitary-adrenal (HPA) system. When a stressful event occurs, the hypothalamus is activated, setting off a chain of events that leads to the production of cortisol. Under normal conditions, stress leads to an increase in cortisol, which causes the body to prepare for handling the stress event. Cortisol responses normally rise sharply soon after awakening followed by a steady decline throughout the day (see Figure 5). The cortisol activity occurring in the first the 45–60 minutes post awakening is referred to as the cortisol awakening response (CAR). Alterations in this normal daily profile may occur under stressed or fatigued circumstances (DeLuca, 2005; Fries et al., 2009; Kumari et al., 2009; Schlotz, Hellhammer, Schulz, & Stone, 2004; Whitehead, Perkins-Porras, Strike, Magid, & Steptoe, 2007).

Figure 5. Mean Cortisol Levels (Standard Error Bars) at all Times of Collection for CNH (Open Squares) and Two CHL (Solid Square and Triangle). Elevated cortisol values exhibited by the CHL are associated with chronic stress, perceived stress, anxiety, and worrying about the burdens of the upcoming day.



Children with hearing loss who are stressed and/or fatigued may also show alterations (e.g., lower or higher cortisol levels) in the normal activity of the HPA system. Lower than normal cortisol levels (hypocortisolism) have been observed in individuals with chronic fatigue syndrome (CFS); (Fries, Hesse, Hellhammer, & Hellhammer, 2005; Jerjes, Cleare, Wessely, Wood, & Taylor, 2005; Roberts, Wessely, Chalder, Papadopoulos, & Cleare, 2004)—a disabling stress-related disease with a primary fatigue symptomatology (Demitrack et al., 1991; Parker, Wessely & Cleare, 2001).

Children with hearing loss who are stressed and/or fatigued may also exhibit lower than normal cortisol values similar to that seen in CFS. To explore this possibility, Hicks and Tharpe (2002) collected cortisol samples twice a day in 10 CHL and 10 CNH. The first sample was collected at the beginning of the school day (9 a.m.) and the second sample was taken at the end of the school day (around 2 p.m.); no significant differences in cortisol values were observed between the two groups at either time point. Several reasons may account for this finding and include sampling protocol, small sample size, and the potential influence of hearing aids worn by the children. Of course, it is possible that no differences actually exist.

Children with hearing loss who are stressed and/or fatigued might also exhibit elevated, rather than blunted cortisol values. Preliminary work by Gustafson and coworkers (2013) found that some CHL exhibited higher cortisol responses than CNH especially at the time point of awakening. Examples of cortisol profiles obtained in a group of CNH and two CHL are shown in Figure 5. It is seen that the CNH exhibit a normal circadian pattern.

The two CHL, however, showed marked deviations from the early morning profile of CNH. The first child with hearing loss (HL1) exhibited a very high cortisol value at awakening followed by a decline throughout the remainder of the day—there was no increase in cortisol levels from awakening. The second child with hearing loss (HL2) exhibited the more typical increase from awakening to 30 minutes post awakening followed by steady decline thereafter; however, the cortisol levels in early morning were elevated relative to CNH. Elevated early morning cortisol levels, such as that seen in the CHL, are associated with chronic social stress, perceived stress, anxiety, and worrying about the burdens of the upcoming day (Wust, Federenko, Hellhammer, & Kirschbaum, 2000; Wust, Wolf, et al., 2000). It thus appears that the two CHL need to mobilize much more energy than CNH before school starts in order to prepare for the day. Such early energy requirements may put CHL at increased risk for fatigue.

Identification and Management of Fatigue

There is mounting evidence to suggest that CHL are at increased risk for cognitive fatigue. Consequently, audiologists will be called upon to play an increasingly important role in the identification and management of CHL who exhibit listening effort, stress, and subsequent fatigue in school. Perhaps the simplest way to identify children at risk for fatigue is to be on the alert for symptoms commonly associated with fatigue in children—such symptoms as tiredness, sleepiness in the morning, inattentiveness, mood changes, and changes in play activity (e.g., decrease in stamina; Bess & Hornsby, 2014). Children suspected of fatigue should receive a subjective fatigue evaluation to confirm its presence and to determine the intensity and characteristics of the fatigue (for information on fatigue scales for children, see Hockenberry et al., 2003; Hornsby et al., 2014; Varni et al., 2002; Varni et al., 2004).

Evidence-based intervention strategies are not yet available for CHL identified with fatigue —until such evidence emerges, several management approaches for children with fatigue are suggested—they include amplification, classroom strategies, and education.

Amplification

Problems in listening/fatigue may be minimized through the use of special hearing technology such as directional microphones and/or the use of hearing assistance technology systems (HATS; Hornsby, 2013). Hence, the identification of those CHL who are at increased risk for fatigue may improve the hearing aid fitting process. Hearing aid selection in children typically involves the identification of a hearing aid(s) that afford the best speech understanding in noisy conditions. While a reasonable starting point, some hearing aid technologies (e.g., digital noise reduction, frequency lowering), which might impact effort and fatigue, may have only a minimal effect on speech understanding (Ching et al., 2013; McCreery et al., 2012; Pittman, 2011b). Thus, in addition to optimizing speech understanding and comfort, an alternative approach to fitting children with hearing aids might include procedures to determine whether or not a given hearing aid technology minimizes listening effort and hearing-related fatigue under adverse listening conditions. Finally, recent evidence suggests that properly fitted hearing aids in both adults and children can make a difference by reducing listening effort and cognitive fatigue (Hornsby, 2013; Rentmeester et al., 2013). Unfortunately, not all CHL wear their hearing aids and/or FM systems in school. Gustafson and coworkers (2013) reported that younger CHL (7–10 years) are more likely to be consistent users of hearing aids and FM systems in the school setting than older CHL (11–12 years) irrespective of the severity of hearing loss. The importance of CHL wearing properly fitted amplification devices throughout the school day cannot be overemphasized.

Classroom Strategies

It is not unreasonable to expect that CHL who are fatigued will be presented with unique listening and learning challenges, especially when attention and concentration resources are needed to deal with the demands of verbal comprehension in a noisy classroom. Classroom strategies might include recommending preferential seating to minimize environmental distracters, slowing the pace of a lesson to allow for additional processing time, limiting the duration of lessons when the primary content is auditory, and providing small group instruction as often as possible. Other strategies might include utilizing breaks as a means to transition between activities, arranging the day so that the most demanding listening tasks occur earlier when children have more resources to cope with these tasks and limiting to later in the day those tasks that require fewer listening resources. Parents and other family members may also benefit from this knowledge by structuring time away from the classroom to allow for periods of relaxation and rest.

Education

Most regular schoolteachers and health care professionals are unaware that CHL can be at increased risk for fatigue and that such fatigue imposes negative psychosocial and educational consequences. In fact, schoolteachers feel ill prepared to deal with children who have chronic health conditions (Clay, Cortina, Harper, Cocco, & Drotar, 2004). Hence, it would seem beneficial to initiate educational programs designed to target teachers, physicians, and family members about the subject of fatigue in CHL. Such awareness programs might include information about fatigue and its consequences, symptoms associated with fatigue, and guidelines for identification and management. To be sure, educational programs should emphasize the importance of CHL wearing their prescribed amplification devices in the school setting. Enhanced awareness and knowledge on the part of all professionals who serve hearing-impaired children should ultimately result in improved services to this population.

Final Remarks

Fatigue is a common phenomenon in our society, and the consequences of fatigue in CHL can be significant—it can impact on educational progress, psychosocial development and even life quality. There is much about fatigue in CHL that we do not know, and research in this area is in the embryonic stages. In fact, as we become more involved in fatigue, the complexity and multifaceted nature of this construct becomes more apparent; indeed, more questions emerge than answers. We do know that some CHL appear to be at increased risk for fatigue. We also know that children with fatigue experience a variety of educational and psychosocial consequences. Accordingly, an important need exists for pediatric audiologists to consider including the construct of fatigue in the identification/assessment of CHL. Finally, it is almost superfluous to note that the importance of research related to fatigue in CHL is paramount—we need to know more about the construct of fatigue in children with varying types and degrees of hearing loss. We also need information related to the prevalence of fatigue, its consequences, and its mechanisms. Evidence-based management strategies need to be developed. To be sure, the need for a fatigue scale designed specifically for CHL loss is a crucial first step in the development of intervention strategies. Although fatigue scales have been developed for a variety of chronic illnesses in children (e.g., cancer, rheumatic arthritis, multiple sclerosis, cerebral palsy, sleep deprivation), none have been designed specifically for CHL. Moreover, most available fatigue scales have been developed from the armchair and have excluded the voice of children themselves and their parents.

This review was developed to enhance the awareness of fatigue among those audiologists interested in serving CHL. To this end, we have presented an overview on fatigue in CHL including its importance, definitions, prevalence, consequences and recent developments. The complexity and multifaceted nature of fatigue has been highlighted and the need for additional research on fatigue in CHL is emphasized.

"Nothing is so fatiguing as the eternal hanging on of an uncompleted task"

William James, 1881. (as cited in DeLuca, 2005, p. 37)

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