Research Article

Associations Between Parenting Stress, Language Comprehension, and Inhibitory Control in Children With Hearing Loss

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Purpose: Parenting stress has been studied as a potential predictor of developmental outcomes in children with normal hearing and children who are deaf and hard of hearing. However, it is unclear how parenting stress might underlie at-risk spoken language and neurocognitive outcomes in this clinical pediatric population. We investigated parenting stress levels and the shared relations between parenting stress, language comprehension, and inhibitory control skills in children with and without hearing loss (HL) using a cross-sectional design.

Method: Families of children with HL ($n = 39$) and with normal hearing ($n = 41$) were tested. Children completed an age-appropriate version of the Concepts & Following Directions subtest of the Clinical Evaluation of Language Fundamentals and the NIH Toolbox Flanker Test of Attention and Inhibitory control. Caregivers completed the Parenting Stress Index–Short Form 4.

Results: Parenting stress levels were not significantly different between parents of children with and without HL. A significant negative association was observed between parenting stress and our measure of language comprehension in children with HL. A negative association between parenting stress and inhibitory control skills was also found in families of children with HL, but not hearing children. The parenting stress–inhibitory control relationship was indirectly accounted for by delayed language comprehension skills in children with HL.

Conclusion: Even at moderate levels of parenting stress similar to parents of children with normal hearing, increases in parenting stress were associated with lower scores on our measures of language comprehension and inhibitory control in children with HL. Thus, parenting stress may underlie some of the variability in at-risk pediatric HL outcomes.

Among parenting characteristics of interest in families of children with hearing loss (HL), caregiver stress has been studied as a consequential attribute of the family system following the diagnosis of a significant, permanent sensory loss (Åsberg, Vogel, & Bowers, 2008; Lederberg & Golbach, 2002; Meadow-Orlans, 1994; Meinzen-Derr, Lim, Choo, Buyniski, & Wiley, 2008; Pipp-Siegel, Sedey, & Yoshinago-Itano, 2002; Quittner, Glueckauf, & Jackson,

1990; Quittner, Steck, & Rouiller, 1991; Quittner et al., 2010; Zaidman-Zait, 2008; Zaidman-Zait, Most, Tarrasch, Haddad-Eid, & Brand, 2016). Parenting stress has been linked to atypical delays in language and socio-emotional behavioral outcomes in children with HL (Calderon & Greenberg, 1999; Hintermair, 2006; Sarant & Garrard, 2013; Topol, Girard, Pierre, Tucker, & Vohr, 2011). However, self-reported levels of parenting stress have differed across studies. It is possible that these conflicting findings might reflect underlying variability in parenting stress across families of children with HL due to measurement differences, small sample size, pediatric HL characteristics, or parental experience with HL management. However, less attention has been given to the association of parenting stress with individual differences in critical outcomes of interest in children with HL. Specifically, is parenting stress associated with at-risk spoken language and neurocognitive outcomes in children with HL?

Parenting Stress and Developmental Outcomes

Parenting stress can be defined as an aversive psychological reaction deriving from the demands of rearing a

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child (Deater-Deckard, 1998). Although often used interchangeably, parenting stress differs from parental stress in that the latter represents the broader scope of perceived burdens and challenges that parents experience, not limited to the child-rearing dynamic (see also Kazdin & Whitley, 2003; Takeuchi, Williams, & Adair, 1991). As an important component to the parental stress profile, parenting stress represents a widely studied familial and developmental risk factor. In samples of families of children with normal hearing (NH), elevated levels of parenting stress have been associated with less effective parenting strategies (Coldwell, Pike, & Dunn, 2006) and poorer social and behavioral outcomes in children (Anthony et al., 2005; Briggs-Gowan, Carter, Skuban, & Horwitz, 2001; Crnic & Low, 2002; Shin, Park, Ryu, & Seomun, 2008). Increased levels of parenting stress also can adversely affect the development of executive function (EF), a set of higher order neurocognitive processes underlying controlled, planned, and effortful behavior. For example, De Cock et al. (2017) reported that parenting stress mediated the relationship between early parent-child bonding and the development of EF in a sample of children with NH. The development of inhibitory control, a core EF skill, appears to be particularly vulnerable to elevated stress levels within the family system (Brown, Ackerman, & Moore, 2013; Evans & Kim, 2013). Thus, parenting stress may threaten some domains of behavioral adjustment and neurocognitive outcomes for children with NH.

Parent- and child-related stressors produce a complex pattern of aversive parent-child interactions that ultimately contribute to suboptimal developmental outcomes (Crnic & Low, 2002). A child's temperamental and behavioral dispositions can introduce stresses and challenges for parents to effectively manage (Crnic & Low, 2002; Osterberg & Hagekull, 2000). Elevated parenting stress, in turn, contributes to poorer parenting competencies and negatively impacts the expression of parental sensitivity, both of which are detrimental to promoting structured transactional experiences between the parent and the child (Belsky, Woodward, & Crnic, 1996; Conger & Donnellan, 2007; De Cock et al., 2017; Deater-Deckard & Scarr, 1996; Grant et al., 2003; Shin et al., 2008). Consequently, family systems experiencing greater stress and disorganized dynamics situate children within environments that are less effective for fostering the development of higher order neurocognitive and self-regulatory processes (Blair & Raver, 2012; Brown et al., 2013; De Cock et al., 2017; Evans & Kim, 2013). Additionally, increased parenting stress can affect physiological processes underlying early brain development critical for supporting emergent EF abilities (Blair, 2010; Blair & Raver, 2012).

Parenting Stress and At-Risk Outcomes in Children With HL

Parenting stress has also been studied in families of children with HL. Parents of children with HL face unique management challenges following the diagnosis of their child's HL (Jackson & Turnbull, 2004). This pediatric

population possesses a long-term, chronic sensory impairment requiring effortful surveillance and support, and HL and its related spoken language delays affect the communication dynamic between the parent and the child (Bergeson, 2011; Cruz, Quittner, DesJardin, Marker, & CDaCI Investigative Team, 2013). However, studies evaluating the extent to which parents of children with HL experience elevated parenting stress have produced mixed results. Elevated general and disability-specific parenting stresses have been reported in several studies (Lederberg & Golbach, 2002; Quittner et al., 1990, 1991). Other investigations either found no significant group differences in general self-reported parenting stress (Åsberg et al., 2008; Lederberg & Golbach, 2002; Meadow-Orlans, 1994; Quittner et al., 2010; Sarant & Garrard, 2013) or found that caregivers with children with HL reported significantly less parenting distress relative to normative data (Pipp-Siegel et al., 2002).

Plausible reasons exist for the variability in self-reported parenting stress among families of children with HL. One primary reason is differences in the measurement of self-reported parenting stress. Several investigations used the Parenting Stress Index (PSI; Abidin, 1983, 1995, 2012), a self-report measure quantifying dimensions of general parenting stress (Åsberg et al., 2008; Lederberg & Golbach, 2002; Meadow-Orlans, 1994; Pipp-Siegel et al., 2002; Quittner et al., 1990, 1991, 2010; Sarant & Garrard, 2013). A number of other studies have used questionnaires (e.g., Family Stress Scale: Quittner et al., 1990; Questionnaire on Resources and Stress: Friedrich, Greenberg, & Crnic, 1983) that measure parenting stresses in the context of having a child with HL (Lederberg & Golbach, 2002; Quittner et al., 1990, 1991, 2010). Studies employing context-specific measurements of parenting stress appear to be more consistent in finding elevated caregiver stress levels in families of children with HL. These questionnaires are likely sensitive to capturing the unique and specific parenting stresses associated with managing a long-term sensory condition that results in language delay and communicative mismatches between NH parents and children with HL (Quittner et al., 2010). Indeed, Deaf parents of Deaf children (who, by definition, do not have a communication mismatch) have less parenting stress than NH parents of children with HL (e.g., Prendergast & McCollum, 1996). Furthermore, variability in parenting stress across studies could also be attributed to small sample sizes in some investigations, variability in degree of HL (e.g., children with hearing aids [HAs] or cochlear implants [CIs]), and varying levels of parental experience with HL management following diagnosis and intervention (Lederberg & Golbach, 2002; Meinzen-Derr et al., 2008).

Although context-specific measures of parenting stress appear sensitive in capturing elevated stress levels among families of children with HL, context-specific measures do not capture the broad spectrum of stressors experienced in the family system and focus instead exclusively on stressors relevant to parenting children with HL. General parenting stress related to everyday child-rearing challenges—whether HL related or otherwise—may therefore capture a broader

set of potential stress-related influences on at-risk language and neurocognitive outcomes for children with HL. Furthermore, investigations evaluating the impact of general parenting stress in families of children with other chronic pediatric conditions suggest that measures of general parenting stress are related to outcomes and condition management (Barakat et al., 2007; Powers et al., 2002; Streisand, Braniecki, Tercyak, & Kazak, 2001). Therefore, the current investigation examines general parenting stress because of its ability to broadly characterize parenting stress within the family system.

The relation between parenting stress and at-risk developmental outcomes has received some attention in families of children with HL. Elevated self-reported stress levels in parents of children with HL are associated with social-emotional difficulties and internalizing and externalizing behavior problems in children (Calderon & Greenberg, 1999; Hintermair, 2006; Topol et al., 2011) as well as poorer spoken language skills in children (Quittner et al., 2010; Sarant & Garrard, 2013). However, the mechanisms underlying parenting stress and pediatric HL outcomes are still largely unknown. Quittner et al. (2010) proposed that language delays can adversely affect behavior and self-regulatory skills of children with HL, which could produce increases in communication difficulties between parent and child and elicit parental feelings of stress. However, studies investigating the associations between parenting stress and outcomes in children with HL have used cross-sectional designs, limiting the extent to which directional relations and mechanistic underpinnings between at-risk developmental outcomes and parenting stress can be pinpointed.

Although support exists for a directional relationship whereby the spoken language abilities of children with HL contribute to parenting stress, parenting stress could also contribute to spoken language variability in children with HL. HAs and CIs provide users' access to the acoustic speech signal to varying degrees (Lederberg & Spencer, 2008; Stiles, Bentler, & McGregor, 2012). Some aspects of the parent-child interaction, such as high-quality linguistic input and communicative redundancy, can help to moderate some of the negative effects of HL on children's spoken language development (Ambrose, VanDam, & Moeller, 2014; VanDam, Ambrose, & Moeller, 2012;). However, greater parenting stress in families of children with HL might alter parent-child interactions such that conversational and turn-taking characteristics of the parent-child communication interaction are adversely affected in a clinical population already reliant on high-quality linguistic experiences. In NH populations, increased parenting stress contributes to more controlling and less responsive parenting behaviors that foster lower quality and quantity of linguistic input (Calkins, Hungerford, & Dedmon, 2004; Noel, Peterson, & Jesso, 2008). While detrimental to development in NH populations, these critical transactional behaviors could lead to significant difficulties for children with HL to fully acquire language.

Parenting stress might also be associated with EF outcomes in children with HL, and spoken language skills

might account for this relationship. Considerable variability in spoken language and neurocognitive outcomes exist for children with HL (Beer et al., 2014; Kral & Sharma, 2012; Kronenberger et al., 2013; Niparko et al., 2010; Pisoni, Conway, Kronenberger, Henning, & Anaya, 2010). Early experience with spoken language affords opportunities for online processing of the temporally ordered acoustic units comprising speech, an activity that promotes engagement with core EF processes (Conway, Pisoni, & Kronenberger, 2009). EF processes, specifically verbal working memory and inhibitory control, also support effortful engagement with spoken language. As a result, verbal working memory and inhibitory control have been associated with language comprehension abilities in children with HL (e.g., Figueras, Edwards, & Langdon, 2008; Kronenberger et al., 2013), as fluent manipulation and controlled processing of the elements of spoken language support comprehension skills.

The underlying mechanism linking parenting stress and EF is unknown in children with HL. Increased parenting stress could foster environmental and transactional conditions between parents and children that are not conducive to positive EF development, such as a chaotic home environment and failure to model or teach effective EF behaviors such as inhibition and organization. Additionally, it is possible that spoken language skills mediate the relationship between parenting stress and EF. That is, parenting stresses might affect parent-child communication such that the child receives less guidance and experience with the use of language to then deploy and regulate EF skills.

This Study

Existing research on parenting stress in families of children with HL has yielded inconsistent results. Furthermore, the extent to which parenting stress is associated with inhibitory control skills in children with HL, and whether spoken language skills account for this relationship, is unknown. The present cross-sectional study was carried out to address these gaps in knowledge of parenting stress and individual differences in outcomes in children with HL. The study had three objectives: (a) to compare relative stress levels in parents of children with HL and parents of children with NH; (b) to investigate relations between parenting stress, language comprehension, and inhibitory control of children with HL; and (c) to determine if relations among these factors differed with child hearing status. We predicted that self-reported parenting stress levels would not differ significantly with child hearing status. However, we expected that self-reported parenting stress would be negatively associated with inhibitory control skills in both children with NH and children with HL, as parenting stress is a risk factor for neurocognitive development. We did not anticipate to find a relationship between general parenting stress and spoken language in children with NH. Although children with NH rely on their caregivers to acquire spoken language, these children are at much lower risk for language delay in general, and study inclusion criteria further limited this risk. Furthermore, because we did not specifically

sample NH families with significant socioeconomic hardship or other significant global influences on parenting stress, we expected that our NH sample would, on average, not fall in a range of parenting stress that placed sufficient pressure on language learning to result in a significant parenting stress–language association in this study. Thus, we did not anticipate relations between parenting stress and language in our sample of children with NH. In contrast, consistent with previous research, we predicted a significant association between parenting stress and spoken language for children with HL because parenting stress might alter communicative opportunities for children with HL and because children with HL already rely heavily on those communicative opportunities for language development. Furthermore, in families of children with HL only, we expected that spoken language skills would account for the shared variability between self-reported parenting stress and inhibitory control given that spoken language delay is associated with parenting stress and that spoken language delay contributes to neurocognitive weaknesses, particularly in samples of children with HL (Kronenberger, Beer, Castellanos, Pisoni, & Miyamoto, 2014).

Method

Participants

Families were enrolled as part of the Families and Hearing Study, a longitudinal project in which both children and families are followed for 3 years to examine the role of family environment and family dynamics on at-risk developmental outcomes in children with HL who use CIs and/or HAs. Although the Families and Hearing Study is currently ongoing, the current analysis comprises the first assessment visit of 39 families of children with HL and 41 families of children with NH—the entire available data set at the time of analysis. Of the children with HL, 18 were HA users only ($M_{\text{age}} = 6.45$ years, $SD = 1.71$ years) and 21 were CI users ($M_{\text{age}} = 6.80$ years, $SD = 1.42$ years). Regardless of sensory aid intervention, all children were diagnosed with bilateral sensorineural HL and started intervention by 2 years of age. Additionally, children with CIs were implanted by 3 years of age and had at least 6 months of experience with their devices. Of the CI children, 20 were bilaterally implanted, and one was unilaterally implanted (and used an HA in the contralateral ear). All children with HL were enrolled in English-speaking, auditory–oral intervention programs that emphasized listening and spoken language skills. Children with HL and their families were excluded from participation if the child was diagnosed with auditory neuropathy spectrum disorder, if the child had other neurodevelopmental disabilities or delays not closely associated with HL, or if HL diagnosis and first HA fitting occurred after the age of 2 years and/or cochlear implantation occurred after 3 years of age. One parent was enrolled per family, including 38 mothers and one father of children with HL.

A control group of NH children ($M_{\text{age}} = 5.67$ years, $SD = 1.72$ years) and their families were also enrolled.

Parents of NH children expressed no concerns regarding their child's speech, language, motor, sensory, or cognitive development. All NH children passed a behavioral hearing screening bilaterally at 25 dB HL at 500, 1000, 2000, and 4000 Hz (American National Standards Institute, 2004, 2010) at the time of assessment. One parent was enrolled per family, including 39 mothers and two fathers of NH children.

Regardless of hearing status, all children were required to have English-speaking caregivers and to receive educational instruction in spoken English. All children scored within 2 SDs (T score > 30) of the mean on a subtest of nonverbal intelligence—the Picture Similarities subtest of the Differential Abilities Scales–Second Edition (Elliot, 2007). All enrolled families resided in Ohio or Indiana, with the majority living in the Columbus, OH, and Indianapolis, IN, metropolitan areas. Children with HL were recruited from local medical centers, were referred from local or statewide service providers and agencies, or answered local advertisements.

Table 1 displays a summary of the demographic characteristics of children with HL and NH. Independent-samples t tests and Pearson chi-square analyses were carried out to compare the demographic characteristics of the two groups. Children with HL were significantly older than children with NH, $t(78) = 2.65$, Cohen's $d = 0.605$, $p = .01$, and had significantly lower receptive vocabulary, measured using the Peabody Picture Vocabulary Test–Fourth Edition (Dunn & Dunn, 2007), than children with NH, $t(78) = 3.43$, Cohen's $d = 0.764$, $p = .001$. However, there were no significant differences in mean annual family income, $t(78) = 1.25$, Cohen's $d = 0.432$, $p = .213$; parent education level, $t(78) = 1.34$, Cohen's $d = 0.321$, $p = .185$; and child gender, $\chi^2(1) = 1.229$, $p = .268$, between families of children with NH and families of children with HL. Within the HL group, analyses were also conducted to compare the demographic characteristics of the HA and CI subgroups. Although the HA and CI groups differed (as expected) on hearing age, $t(37) = 3.62$, Cohen's $d = 0.605$, $p = .0009$, and pure-tone average (PTA; average auditory thresholds for the better ear at 500, 1000, 2000, and 4000 Hz; aided PTA: $t(23) = 2.39$, Cohen's $d = 0.767$, $p = .03$; unaided PTA at diagnosis: $t(28) = 51.66$, Cohen's $d = 5.33$, $p < .0001$), there were no significant differences between HA and CI groups on mean annual family income, $t(37) = 1.88$, Cohen's $d = 0.444$, $p = .07$; parent education level, $t(37) = 0.73$, Cohen's $d = 0.234$, $p = .56$; child age, $t(37) = -0.93$, Cohen's $d = 0.310$, $p = .35$; receptive vocabulary, $t(37) = 1.69$, Cohen's $d = 0.546$, $p = .09$; and child gender, $\chi^2(1) = 0.04$, $p = .84$. Therefore, we combined the HA and CI groups into a single HL group to increase power in the statistical analyses reported below.

Materials

Parenting Questionnaires

Parenting stress. The PSI–Short Form 4 (PSI-4-SF; Abidin, 2012), a 36-item self-report measure of general parenting-related stresses, was used to quantify stress within the family system. The items are answered on a 5-point rating

Table 1. Family and child demographics and hearing history.

Participant characteristics	NH	HL (CI and HA)	CI	HA
<i>n</i>	41	39	21	18
<i>n</i> , male/female	24/17	20/19	10/11	9/9
Average caregiver education ^a	4.70 (1.4)	4.20 (1.7)	4.00 (1.7)	4.41 (1.8)
Average annual family income ^b	8.60 (1.7)	7.65 (2.6)	7.11 (3.2)	8.28 (1.9)
PPVT-4, age-based standard score	101.42 (11.3)**	91.74 (16.2)	88.56 (16.1)	97.01 (14.8)
Chronological age, child (years)	5.67 (1.7)*	6.64 (1.5)*	6.89 (1.3)	6.42 (1.7)
Audiological characteristics				
Hearing age (years) ^c	—	5.04 (2.2)	4.06 (2.3)	6.32 (1.4)
Aided 4-frequency PTA ^d (dB HL)	—	23.92 (8.4)	27.05 (6.8)	20.62 (9.7)
Unaided 4-frequency PTA ^{d,e} (dB HL)	—	70.27 (29.7)	101 (13.5)	50.06 (16.5)

Note. Em dashes indicate data not applicable. NH = normal hearing; HL = hearing loss; CI = cochlear implant; HA = hearing aid; PPVT-4 = Peabody Picture Vocabulary Test–Fourth Edition; PTA = pure-tone average re: American National Standards Institute (2004).

^aParental education was coded based on levels of formal education: 1 = *some high school*, 2 = *high school diploma*, 3 = *some college*, 4 = *associate degree*, 5 = *bachelor's degree*, 6 = *master's degree*, and 7 = *doctorate degree*. ^bParents indicated their annual income from the following income brackets: 1 = *under \$5,000*; 2 = *\$5,000–\$9,999*; 3 = *\$10,000–\$14,999*; 4 = *\$15,000–\$24,999*; 5 = *\$25,000–\$34,999*; 6 = *\$35,000–\$49,999*; 7 = *\$50,000–\$64,999*; 8 = *\$65,000–\$79,999*; 9 = *\$80,000–\$94,999*; and 10 = *\$95,000 and over*. ^cHearing age was calculated by subtracting chronological age at time of assessment from age at which child was fit with hearing aids (HA group) or fit with cochlear implants (CI group). ^dCalculated at 0.5, 1, 2, and 4 kHz. ^eAt time of HL diagnosis.

* $p < .05$. ** $p < .01$.

scale of agreement and are divided into three subscales: The Parental Distress subscale assesses feelings of distress concerning personal resources, responsibilities, and competence as a parent; the Parent–Child Dysfunctional Interaction subscale assesses stresses associated with the quality and nature of the parent–child bond; and the Difficult Child subscale assesses stresses associated with the behavioral characteristics of the child and related management considerations. Additionally, the three subscales are summed to produce an index of total parenting stress experienced within the family and parenting context. The summed raw score was used for all analyses.

In addition to the PSI-4-SF, all parents completed a general demographic questionnaire. One of the items posed an open-ended question in which parents were asked to list up to five sources of parental stress in the last 6 months. Two coders independently categorized all parent-reported stresses into suprorordinate categories. Commonly encountered categories included, but were not limited to, “Child Behavior” (e.g., stresses concerning conduct challenges exhibited by children), “Domestic” (e.g., stresses concerning home upkeep and property related matters), “Education” (e.g., stresses concerning schooling and academic issues), “Family” (e.g., stresses concerning individual or multiple family members or relations between family members), “Financial” (e.g., stresses concerning money or financial matters), “General Healthcare” (e.g., stresses concerning ongoing medical or health-related conditions in the family; for families of children with HL, stresses concerning HL were not included in this category), “Parenting” (e.g., stresses concerning caregiving responsibilities and child rearing), “Time Management” (e.g., stresses concerning time organization and planning), “Travel” (e.g., stresses concerning daily transportation and commuting considerations), and “Work” (e.g., stresses concerning occupational and professional burdens and responsibilities). Although infrequent, two types

of stress concerning pediatric HL were reported and were categorized: “Educational Considerations” (e.g., stresses concerning classroom placement and Individualized Education Program management based on HL) and “Language Development” (e.g., stresses concerning the acquisition, development, and mastery of spoken language). Categorization interrater reliability was good, with agreement reached on 94% of reported stressors ($n = 307$). For the 17 stressors of which there was disagreement, the coders reviewed each case and discussed pertinent categorization considerations until agreement was established. Parental responses and derived subordinate categories reflect parental stresses, which are the broader burdens that parents experience, which may or may not include perceived challenges associated with child rearing (e.g., parenting stress). Furthermore, they may or may not include perceived challenges related to the hearing status of the child.

Child Assessments

Language comprehension. Language comprehension was assessed using a single measure for this study. Depending on the child’s age, the Concepts & Following Directions (C&FD) subtest of the Clinical Evaluation of Language Fundamentals Preschool–Second Edition (CELF Preschool-2; Wiig, Secord, & Semel, 2004) or the Following Directions subtest of the Clinical Evaluation of Language Fundamentals–Fifth Edition (CELF-5; Semel, Wiig, & Secord, 2013) was used. The CELF is a standardized normed measure of complex receptive and expressive language abilities. The Following Directions (CELF-5) and C&FD (CELF Preschool-2) subtests specifically assess comprehension of spoken utterances that progressively increase in length and linguistic complexity. Although these subtests have slightly different names and differ in difficulty across the two CELF age-based versions, they have very similar content and measure identical constructs; therefore, a single variable was

created reflecting CELF C&FD scores across the CELF-5 and CELF Preschool-2 tests. CELF C&FD subscale scaled scores (means of 10 and *SDs* of 3 compared to nationally representative age-normed sample) were used in this study as a single measure of language comprehension.

Neurocognition: inhibitory control. The Flanker Inhibitory Control and Attention Test (Flanker Test) of the NIH Toolbox iPad Cognition Battery application (Gershon et al., 2013) requires participants to attend to and indicate the direction of a target arrow while ignoring distractor arrows that point either in the same direction or in the opposite direction as the target arrow. Children between 3 and 7 years of age begin the task with pictures of fish instead of arrows and are administered arrows if they score 90% or above with the fish stimuli. Twenty-five of 28 children with NH completed both fish and arrow trials; 19 of 29 children with HL completed both fish and arrow trials. Age-corrected standard scores are derived based on a combination of accuracy and reaction time.

Procedure

Research questionnaires (including the PSI-4-SF) and the demographic questionnaire were completed by the parent prior to a home visit. All in-person testing was completed at the home visit by a pair of trained clinical researchers with extensive backgrounds in speech-language pathology, audiology, and/or pediatric HL.

In accordance with this study's approved institutional review board protocol, parents were mailed consent and parental permission forms. Parents completed consent and parental permission over the phone with a trained research assistant before starting the questionnaires. At the home visit, clinical researchers collected the consent and permission forms along with the completed questionnaires. Children ages 7 years and older were required to provide assent prior to any in-home testing. All data collection was obtained in accordance with procedures of the local institutional review board.

Data Analysis

Statistical analyses were performed using IBM SPSS v.24 (IBM Corporation). Descriptive analyses were performed on demographic variables and on the family and outcome measures; outlier analyses were performed to determine if subject responses or performance fell more than 2 *SDs* away from the mean—no data reached this criterion on any of the measures reported. Independent-samples *t* tests were performed to compare group differences on family and outcome-related variables. Correlation and regression analyses were performed to assess shared associations and proportions of shared variability between measures of interest. The criterion for significance for all analyses was set at $p < .05$. Simple mediation analyses using the bootstrap confidence interval for the indirect effect were tested using the PROCESS macro for SPSS (Hayes, 2017) to measure strength of the indirect effect of self-reported

parenting stress on child inhibitory control that occurred through CELF C&FD performance. The indirect effect assesses the effect of self-reported parenting stress on CELF C&FD performance (e.g., β_1 coefficient) multiplied by the effect of CELF C&FD on Flanker performance (e.g., β_2 coefficient; see Figure 3). The direct effect is the relative strength of the effect that self-reported parenting stress has on child Flanker performance that is not accounted for by CELF C&FD performance. It should be noted that data for this study were cross-sectionally obtained. Mediation analysis with cross-sectional data can evaluate the presence of indirect effects and provide support for our theoretical model, but causal relationships between variables cannot be established when analyses are conducted with data collected from the same timepoint. Furthermore, traditionally conducted mediation analyses are often conducted using larger sample sizes than presented from this study in order to achieve sufficient power to detect effects. However, bootstrap confidence interval testing is appropriate for sample sizes similar to those reported in this study given that bootstrap resampling methods generate point estimates for indirect effects that are less susceptible to outliers relative to other mediation techniques. Bootstrap confidence interval testing for indirect effects represents an appropriate analytic strategy for smaller sample sizes (Hayes, 2017; Preacher & Hayes, 2004; Shrout & Bolger, 2002).

Results

Comparative and Correlational Analyses

Comparative Analyses

Means and standard deviations for the family and child measures for both groups are displayed in Table 2. Independent-samples *t* tests were conducted to determine if group differences were present for both the family/parent and child measures. As expected, children with NH scored significantly better than children with HL on both the

Table 2. Means and standard deviations of family and child assessments.

Variable	NH	HL
Family measures		
PSI-4-SF, total stress (<i>SD</i>)	70.05 (18.41)	67.54 (20.01)
Child measures		
CELF ^a (<i>SD</i>)**	11.17 (2.70)	8.29 (3.72)
Flanker Test of Inhibitory Control (<i>SD</i>)*	99.37 (13.77)	91.03 (20.19)

Note. NH = normal hearing; HL = hearing loss; PSI-4-SF = Parenting Stress Index–Short Form 4; CELF = Clinical Evaluation of Language Fundamentals.

^aMean scaled scores were collapsed across the Following Directions subtest from the Clinical Evaluation of Language Fundamentals–Fifth Edition and the Concepts & Following Directions subtest for the CELF Preschool-2.

T* test significant between two identified groups, $p < .05$. *T* test significant between two identified groups, $p < .01$.

CELF C&FD, $t(78) = 3.50$, Cohen's $d = 0.88$, $p < .0001$, and on the Flanker Test, $t(78) = 2.17$, Cohen's $d = 0.482$, $p = .03$. For children with HL, there were no significant differences between HA and CI users in performance on the CELF C&FD, $t(37) = 0.98$, Cohen's $d = 0.317$, $p = .33$, or on the Flanker Test, $t(37) = 0.40$, Cohen's $d = 0.129$, $p = .69$.

There was no significant difference in reported parenting stress levels between parents of children with HL and NH, $t(78) = 0.58$, Cohen's $d = 0.131$, $p = .56$. Table 3 displays the top 10 most common sources of parental stress for families of children with HL and NH. The stressors listed were similar between parents of both groups with family, financial, and work-related stresses being the most commonly cited sources in both groups of parents.

Correlational Analyses

Total self-reported parenting stress was negatively correlated with child performance on the CELF C&FD subtest, $r(38) = -.39$, $p = .02$, and on the Flanker Test, $r(38) = -.38$, $p = .01$, for children with HL. For families of children with NH, there were no significant associations between self-reported parenting stress and child performance on the CELF C&FD subtest, $r(40) = .05$, $p = .74$, or child performance on the Flanker Test, $r(40) = .06$, $p = .67$. Fisher's r to z transformations for correlations between groups revealed a significant difference in the correlation coefficients between families of children with HL and NH for both self-reported parenting stress and child language comprehension, $z = -1.97$, $p = .04$, and self-reported parenting stress and child inhibitory control, $z = -2.00$, $p = .04$. Figure 1 displays the relation between parenting stress and child language comprehension, and Figure 2 displays the relation between parental stress and child inhibitory control. In children with HL, performance on the CELF C&FD subtest was significantly associated with performance on the Flanker, $r(38) = .55$, $p < .0001$. There was no significant association between performance on the CELF C&FD and on the Flanker for children with NH, $r(40) = .24$, $p = .12$. Fisher's r to z transformations for correlations between groups revealed no significant difference in the correlation value between children with HL and NH for CELF C&FD and Flanker Test performance, $z = 1.57$, $p = .11$.

Regression Analyses

To evaluate whether language comprehension mediated the relation between self-reported parenting stress and inhibitory control, we first performed a regression analysis to estimate how much variability in children's Flanker performance could be accounted for by parenting stress. The model was not significant for NH children, $F(1, 39) = 0.15$, $p = .69$; however, it was significant for children with HL, $\beta = -0.38$, $R^2 = .14$, $F(1, 37) = 6.32$, $p = .02$, with self-reported parenting stress accounting for over 14% of the variability in Flanker performance alone. An additional multiple regression analysis was conducted in which performance on the CELF C&FD subtest was estimated from self-reported parenting stress. Again, the model was not significant for NH children, $F(1, 39) = 0.10$, $p = .75$. However, for children with HL, the model was significant, $\beta = -0.39$, $R^2 = .15$, $F(1, 37) = 6.34$, $p = .02$. Parenting stress accounted for 15% of the variance in CELF C&FD performance of children with HL.

Mediation Analyses

Bootstrap confidence interval mediation analyses were conducted on our sample of children with HL (see Figure 3) and children with NH (see Figure 4) to evaluate if the relationship between self-reported parenting stress and inhibitory control was associated by language comprehension. Additionally, in our mediation model for children with HL, we included unaided PTA at diagnosis as a covariate to control for differences in early hearing experiences between HA and CI users. For families of children with HL, evidence of mediation was present in which a 1-SD increase in self-reported parenting stress was associated with a 0.40-SD unit decrease in CELF C&FD scaled scores ($\beta_1 = -0.40$, $p = .021$). Among children with HL, a 1-SD increase in CELF C&FD performance was associated with a 0.47-SD unit increase in Flanker Test performance ($\beta_2 = 0.47$, $p = .002$). Parenting stress was indirectly associated with performance on the Flanker test (see Figure 3, $\beta_1 \times \beta_2$, point estimate: -0.19 , 95% confidence interval $[-0.56, -0.01]$). Independent of this mechanism, there was no evidence of a direct effect of total parenting stress on Flanker performance in children with HL. For children with NH, the mediation model

Table 3. Most common parent-reported stressors and the frequency each stressor was reported per group.

NH	HL (CI and HA)	CI	HA
Family, 31	Financial, 24	Financial, 13	Financial, 11
Financial, 28	Family, 23	Family, 12	Family, 11
Work, 23	Work, 18	Work, 9	Work, 9
Domestic, 22	Domestic, 16	Domestic, 9	Domestic, 7
Time Management, 16	Parenting, 11	Parenting, 6	General Healthcare, 5
General Healthcare, 15	General Healthcare, 9	General Healthcare, 4	Parenting, 4
Parenting, 12	Time Management, 7	Time Management, 4	Educational Considerations, 4
Travel, 6	Educational Considerations, 6	Child Behavior, 3	Time Management, 3
Education, 6	Child Behavior, 6	Language Development, 3	Child Behavior, 3
Politics, 4	Language Development, 3	Educational Considerations, 2	Travel, 2

Note. NH = normal hearing; HL = hearing loss; CI = cochlear implant; HA = hearing aid.

Figure 1. Correlations between total parenting stress and child language comprehension skills. The association between stress and language comprehension abilities was significant and negative for children with hearing loss. CELF = Clinical Evaluation of Language Fundamentals; NH = normal hearing; HL = hearing loss.

produced no significant direct or indirect paths (see Figure 4; $R^2 = .063$, $F(1, 39) = 0.69$; $\beta_1 \times \beta_2$, point estimate: 0.01, 95% confidence interval $[-0.04, 0.07]$). In other words, self-reported parenting stress did not influence inhibitory control directly or indirectly through language comprehension in children with NH.

Discussion

This investigation had three objectives: (a) to compare self-reported stress levels of parents of children with NH to those of parents of children with HL, (b) to evaluate whether general parenting stress was related to language comprehension and inhibitory control skills in families of

children with NH and HL, and (c) to determine the extent to which the relations among these factors differed with child hearing status. If evidence of an indirect association between parenting stress and child inhibitory control was observed through children's language, it would be consistent with our hypothesis that parenting stress adversely contributes to at-risk spoken language skills, which subsequently relates to poorer inhibitory control abilities in this clinical pediatric population. To evaluate potential relations between self-reported parenting stress, language comprehension, and inhibitory control, we evaluated children with NH and children with HL and their primary caregivers in their homes.

We found that parents of children with HL and NH were not significantly different in self-reported levels of general (e.g., not hearing- or language-specific) parenting stress. These results were qualitatively supported by parent-reported stressors experienced over the previous 6 months. Parents of children with HL and NH reported similar parental stressors (e.g., domestic, occupational, financial). Furthermore, from the categorized parental stresses, parenting stress was also reported to a similar degree between both groups as well. Thus, the PSI-4-SF and the parental stresses reported by families of children with HL and NH suggest similar parental and parenting stress profiles between these two groups. We found no significant relation between parenting stress and inhibitory control or spoken language in children with NH. There were, however, significant negative associations between self-reported parenting stress and both inhibitory control and language comprehension skills in children with HL. Moreover, for families of children with HL, results supported our mediation model, whereby greater parenting stress was associated with poorer spoken language abilities in children, which were, in turn, associated with poorer inhibitory control skills.

Levels of Parenting Stress and Pediatric HL

The lack of an overall group difference in self-reported parenting stress levels between the hearing groups is consistent with a growing body of research showing that caregivers of children with HL do not experience more general parenting stress than parents of normal hearing children (Åsberg et al., 2008; Lederberg & Golbach, 2002; Meadow-Orlans, 1994; Quittner et al., 2010; Sarant & Garrard, 2013). Quittner et al. (2010) argued that investigations using questionnaires evaluating general parenting-related stress levels (e.g., PSI, PSI-4-SF) appear less sensitive at capturing stresses within the family system related to managing pediatric HL. She argued that, although such condition-specific stresses exist, they likely are not overtly intrusive enough to impact perceptions of overall parenting-related stress. Our data support the observation from Quittner et al. (2010) that the most common sources of stress reported by parents of children with HL were not associated with HL, rehabilitation, language, or the child's sensory aid. In fact, parents of children in both groups reported very similar sets of common stressors that were not related to HL. Therefore,

Figure 2. Correlations between total parenting stress and child performance on the Flanker. The association between stress and inhibitory control was significant and negative for children with hearing loss. NH = normal hearing; HL = hearing loss.

Figure 3. Mediation model demonstrating relations between family stress and inhibitory control performance via language comprehension skills in children with hearing loss. The 95% confidence interval (95% CI) for the indirect effect (β_1 path $\times$ β_2 path) does not include 0. Independent of this indirect effect, there is no significant direct effect of stress on inhibitory control. β coefficients are standardized regression weights.

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although the PSI-4-SF does not tap into any potential differences between parents of NH children and children with HL, it does appear to be an appropriate measure for quantifying many of the potentially high-impact stresses that contribute to family systems of children with HL.

Another plausible reason for the null differences in overall self-reported parenting stress levels concerns *when* parenting stress is measured. Parent-related stress remains relatively stable over time among families of children with HL (Lederberg & Golbach, 2002), but periods of transition temporarily alter the magnitude of stress parents experience at specific moments in the child's life (at the time of HL diagnosis, during sensory device fitting, determining appropriate educational plans, etc.). These stresses tend to decrease once parents have had more experience and familiarity with management of their child's HL. As certain stress levels wane, other new, HL-specific stressors ramp up later in childhood (e.g., educational concerns and peer relationships during the grade school years), indicating that different dimensions of stress ebb and flow during the child's development (Meinzen-Derr et al., 2008). In our sample of children with HL, on average, parents had 5 years' worth of experience with sensory aid management. It is likely that many of the initial HL-specific stresses that were experienced shortly following diagnosis and intervention had diminished and stabilized by the time of study enrollment.

Parenting Stress and At-Risk Outcomes

Contrary to our initial expectations, self-reported parenting stress was not associated with inhibitory control abilities in our sample of children with NH. These results were unexpected as elevated parenting stress levels have been demonstrated to adversely impact self-regulatory and neurocognitive development in NH pediatric populations (Blair, 2010; Blair & Raver, 2012; Brown et al., 2013; De Cock et al., 2017; Evans & Kim, 2013). However, some studies evaluating relations between parenting stress and EF-related skills have also targeted families experiencing economic hardships (Brown et al., 2013; Evans & Kim, 2013). Indeed, socioeconomic adversity has been associated with poor developmental outcomes (Bradley & Corwyn, 2002; Noble, McCandliss, & Farah, 2007) and can foster elevated parental stresses that suboptimally contribute to development (Brown et al., 2013; Deater-Decker & Scarr, 1998). Other studies have also focused on the developmental effects of parenting stress in younger children or in clinical populations where relations might be stronger during earlier developmental windows (Magill-Evans & Harrison, 2001). In this study, the median annual income bracket for NH families was \$80,000–\$94,000, and most enrolled caregivers had a bachelor's degree. These demographic characteristics indicate that our sample of families of NH children might not exhibit the range of contextual

Figure 4. Mediation model demonstrating relations between family stress and inhibitory control performance via language comprehension skills in children with normal hearing. None of the paths in the model were significant. β coefficients are standardized regression weights. 95% CI = 95% confidence interval.

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disadvantages that foster high stress and poorer neurocognitive outcomes.

In contrast to findings for families of children with NH, study results revealed that self-reported parenting stress was negatively associated with language comprehension and inhibitory control for children with HL. These results both extend and support previous findings. First, the association between self-reported parenting stress and spoken language skills is consistent with earlier work in children with HL (Quittner et al., 2010; Sarant & Garrard, 2013). Additionally, this is the first investigation to reveal a negative association between parenting stress and inhibitory control in children with HL. This finding dovetails with previous studies in NH pediatric samples that have found associations between greater parenting stress and poorer EF-related outcomes (e.g., Blair & Raver, 2012; De Cock et al., 2017). Finally, a test of our mediation model revealed that shared variability between parenting stress and child inhibitory control was also shared by language comprehension on the CELF C&FD in children with HL. Parenting stress was negatively related to language comprehension on the CELF C&FD in children with HL, which in turn was positively related to inhibitory control abilities.

Theoretical Implications

Analyses for this study were derived from a single measure of inhibitory control and from one standardized language assessment subtest. Thus, interpretation of the results warrants caution. This study identifies a potential set of relations framing how parenting factors might contribute to at-risk developmental outcomes in children with HL. However, future studies should incorporate additional measures of inhibitory control and language ability to better evaluate the aforementioned constructs and to further understand the interrelations between parenting stress, spoken language, and executive functioning in children with HL.

Children with HL exhibit delays and enormous variability in spoken language outcomes (Eisenberg, 2007; Moeller et al., 2007; Niparko et al., 2010; Nitttrouer & Burton, 2001) and specific parenting and family characteristics might account for some of this variability not explained by medical and intervention history. Parenting stress is one plausible dimension of the family system that appears to be related to at-risk spoken language outcomes. In the general population, increased parenting stress can affect parental responsivity and engagement during communicative exchanges (Magill-Evans & Harrison, 2001; Whiteside-Mansell et al., 2007), characteristics that can influence linguistic input supporting language acquisition (Hoff, 2006; Tamis-LeMonda, Bornstein, & Baumwell, 2001). As an at-risk clinical population, children with HL might be particularly sensitive to parental characteristics during communicative exchanges (Ambrose et al., 2014; VanDam et al., 2012). Given that children with HL experience language delay, future studies should investigate parenting stress and specific aspects of parent-child communication that could impact at-risk language skills in children with HL.

We also found that the shared variability between parenting stress and inhibitory control was also common to our measure of language comprehension. As a consequence of language delay, children with HL are also at greater risk for neurocognitive weakness (e.g., Beer et al., 2014; Figueras et al., 2008; Kronenberger et al., 2013). Future studies should use additional EF measures to evaluate complex relations between spoken language, inhibitory control, and impact of parenting stress on these at-risk developmental outcomes.

Limitations and Future Directions

One primary limitation of the current investigation was that the mediational analysis was conducted using cross-sectional data, which limits the extent to which directional interpretations can be made. Cross-sectional data can be appropriately applied to mediation analyses to test a model that is consistent with the presence of indirect effects, but they cannot establish causal directionality. For example, the direction of the hypothesized cause-effect relationships in Figure 3 (represented by arrows) could be in the reverse direction. Furthermore, it is likely that the stress-language associations are bidirectional. Therefore, an important next step for testing this model would involve the use of longitudinal data to better establish the direction of causality. A second and related limitation concerns the use of single measures of language comprehension and inhibitory control. Given the complex relations between spoken language and neurocognitive abilities (as well as intervening parenting contributions), the results cannot be overextended by broadly prescribing relations between each of these constructs.

A third limitation concerns the age differences between the two groups. The children with HL were significantly older than NH children. The sample of children with HL used for this study averaged 6–7 years of age; thus, their parents had at least 4–5 years of experience with coping with and managing their child's HL. Studies investigating younger and older subsets of children and parent-related stresses would provide a sense for how parenting stress influences outcomes at different periods of child development.

In addition to investigation of longitudinal data at different ages and stages of development, future work should quantify specific caregiver and child behaviors and dyadic transactional processes that are affected by parenting stress in families of children with HL. The role of these specific caregiver-child behaviors and interactions in explaining associations between stress, language, and neurocognitive outcomes may suggest interventions and protective factors that may mitigate developmental risks associated with parenting stress in families of children with HL. Future work should also include socioeconomic and demographic factors in models of parenting stress to further address how parental characteristics and familial resources impact relations between parenting stress and pediatric HL outcomes. Finally, individual differences in parental familiarity, self-efficacy, and expertise over the course of HL diagnosis and management might also affect relations between parenting

stress and pediatric HL outcomes and should be studied in future research.

Conclusions

The present results contribute to a growing body of research demonstrating the effects of parenting stress on at-risk abilities among children with HL with sensory aids. Additionally, this study is the first to document a relation between parenting stress and inhibitory control in children with HL and to show that this association may be indirectly accounted for by child language comprehension skills. The results underscore several important practical considerations for clinicians working with families of children with HL. The first consideration is that the family environment represents a critical contributor to variation in at-risk outcomes, even if family characteristics appear similar to those in families of NH children. Parenting stress represents another property of the family environment that might underlie enormous individual differences in spoken language outcomes for children with HAs and CIs. The second consideration is that families of children with HL require active support from clinical providers to identify sources of stress and to recognize how such stresses might impact at-risk developmental outcomes. Even when stress profiles of families of children with HL are no different from those of the families of children with NH, greater parenting stress was found to be related to at-risk spoken language and neurocognitive skills. Thus, family-based interventions and counseling during clinical appointments that consider overall parenting stress levels could help to maximize outcomes for children with HL.

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