J Am Acad Audiol 29:656–667 (2018)

Measuring Perceptions of Classroom Listening in Typically Developing Children and Children with Auditory Difficulties Using the LIFE-UK Questionnaire

DOI: 10.3766/jaaa.17053

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Abstract

Background: Classrooms can be noisy and are challenging listening environments for children with auditory processing disorder (APD). This research was undertaken to determine if the Listening Inventory for Education-UK version (LIFE-UK) can differentiate children with listening difficulties and APD from their typically developing peers.

Purpose: To investigate reliability and validity of the student and teacher versions LIFE-UK questionnaire for assessing classroom listening difficulties.

Research Design: Cross-sectional quantitative study comparing children with listening difficulties with typically developing children.

Study Sample: In total, 143 children (7–12 yr) participated; 45 were diagnosed with APD. Fifteen participants with reported listening difficulties who passed the APD test battery were assigned to a "listening difficulty" (LiD) group. Eighty three children from nine classrooms formed a Control group.

Data Collection and Analysis: Children and teachers completed the LIFE-UK questionnaire student and teacher versions. Factor analysis was undertaken, and item reliability was assessed using Cronbach's alpha. Teacher and student ratings were compared using Spearman correlations. Correlations between LIFE-UK ratings and APD test results were also investigated.

Results: Factor analysis revealed three factors accounting for 60% of the variance in the Control group LIFE-UK ratings. After removing six items with low factor loadings, a shortened seven-item version with three factors accounted for 71.8% of the variance for the student questionnaire; Cronbach's alpha indicated good internal reliability for this seven-item version of the student questionnaire. Factors were also derived for the teacher questionnaire. Teacher and student ratings were correlated when participant groups were combined. LIFE-UK ratings correlated weakly with some APD measures, providing some support for the questionnaire validity.

Conclusions: The results support the use of either the 13- or 7-item student and the teacher versions of the LIFE-UK to evaluate classroom listening and functional consequences of APD. Factor analysis resulted in groupings of items reflecting differences in listening demands in quiet versus noise for the student questionnaire and attentional versus class participation demands for the teacher questionnaire. Further research is needed to confirm the robustness of these factors in other populations.

Key Words: APD, auditory processing, child ratings, classroom listening, LIFE-UK, questionnaire, self-rating scales, teacher ratings

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Abbreviations: ANOVA = analysis of variance; APD = auditory processing disorder; CHAPS = Children's Auditory Processing Performance Scale; DDT = dichotic digit test; ECLiPS = Evaluation of Children's Listening and Processing Skills; FAPC = Fisher's Auditory Problem Checklist; FPT = frequency pattern test; IVA-CPT = integrated visual and auditory continuous performance test; LiD = listening difficulties; LIFE = Listening Inventory for Education; LIFE-UK = Listening Inventory for Education-United Kingdom version; SD = standard deviation; SIFTER = Screening Instrument for Targeting Educational at Risk

INTRODUCTION

Classroom noise is particularly problematic for school children discriminating speech from the variety of other irrelevant noises in the classroom (Rosenberg et al, 1999). While there are a number of sources of noise and distraction, the biggest source of noise in a classroom is other children speaking (Shield and Dockrell, 2004). A review of 17 independent studies of noise levels for different age groups concluded that younger children tended to have noisier classrooms because of the relatively higher levels of classroom activity (Picard and Bradley, 2001). At primary and secondary level, classroom noise levels of 72 dBA L_{Aeq} are typical, exceeding conversational speech levels (Shield and Dockrell, 2008). As classroom listening skills are important for children's learning, and classrooms are challenging listening environments even for children with normal hearing (Dockrell and Shield, 2004), valid and reliable measures of classroom listening are required to establish the functional impact of hearing difficulties.

Auditory processing disorder (APD) is a complex hearing disorder associated with a range of listening and learning difficulties despite the presence of normal hearing sensitivity (Chermak and Musiek, 2002). Results from different studies reveal a heterogeneous population, with some children showing deficits in frequency discrimination (Bailey and Snowling, 2002; Sharma et al, 2014), attention (Moore et al, 2010; Dhamani et al, 2013), listening in spatialized noise (Cameron and Dillon, 2007), or p dichotic listening (Moncrieff et al, 2016). Questionnaires can complement standardized hearing tests by providing information about functional auditory behavior in everyday situations (Sanger et al, 1987). Questionnaires also provide a link between the audiological condition as determined by the audiologist using standardized tests and actual classroom performance (Smaldino et al, 2004). Despite the range of test difficulties evident for children with APD, they may have similar functional difficulties with classroom listening and academic performance (Hutchinson and Mauer, 1999; Barry et al, 2015; Tomlin et al, 2015).

Questionnaires that yield information about perceived performance in everyday life may be more valuable than standardized clinical tests for monitoring change in everyday listening situations and determining the functional impact of APD (Sanger et al, 1987). Historically the most commonly used questionnaires in the APD field are the Children's Auditory Processing Performance Scale (CHAPS) (Smoski et al, 1992), Screening Instrument for Targeting Educational at Risk (SIFTER) (Anderson and Matkin, 1989), and Listening Inventories for Education (LIFE) (Anderson and Smaldino, 1998). The CHAPS was designed to quantify observed auditory behaviors of children aged 7 yr or more (Smoski, 1990; Smoski et al, 1992). Parents or teachers rate the amount of difficulty the child experiences compared to their peers. The CHAPS includes 36 items relating to 6 listening conditions or functions: Quiet, Ideal, Multiple Inputs, Noise, Auditory Memory/Sequencing, and Auditory Attention Span. These areas represent the most frequently reported auditory difficulties found in children diagnosed with APD (Smoski et al, 1992; Kreisman et al, 2005). The LIFE was developed as an extension to the SIFTER that includes teachers' classroom observations of the child with suspected difficulties (Anderson and Smaldino, 1998) A more recent version of the LIFE has been developed that includes colorful pictures (Anderson et al, 2011). The LIFE consists of a teacher questionnaire and a student self-report questionnaire. The LIFE is one of the few questionnaires that measures student responses directly. Since its introduction in 1998, two additional versions of the LIFE have been developed. Researchers in the United Kingdom adapted the LIFE to reflect the educational context there (Canning, 1999) and to focus on whole-class listening situations only. The Listening Inventory for Education-United Kingdom version (LIFE-UK) teacher questionnaire has pre- and posttest formats to document outcomes of classroom listening interventions. Easily identifiable line drawings were created for each of the 13 questionnaire items, making it easier for children to independently complete the questionnaire; the drawings help younger children and poor readers to complete the questionnaire.

Several studies have used these questionnaires to quantify the effects of sound field and remote microphone hearing aid amplification on classroom listening in children with APD and other populations (McSporran et al, 1997; Palmer, 1998; Stephenson, 2007; Purdy et al, 2009). McSporran et al (1997) found that CHAPS scores improved compared with preintervention scores for 65 participants from 2 mainstream school classrooms after 5 months use of sound field amplification, indicating that CHAPS can be used as an outcome measure when investigating the impact of sound field amplification. The majority of the children in this study

were classified as educationally at-risk possibly because of hearing loss, based on the SIFTER questionnaire (Anderson and Matkin, 1989). The LIFE-UK has been used in studies of classroom amplification and pediatric hearing aid use (Canning, 1999; Purdy et al, 2009). The LIFE-UK study of the efficacy of whole-classroom sound field amplification intervention in the UK involved 600 primary age school children. The UK researchers reported that the questionnaire was highly reliable and sensitive to the effects of the intervention; child and teacher scores showed gains in classroom listening which were not apparent using traditional measures such as reverberation time, speech transmission index, and percentage loss of consonants. The LIFE-UK was used in a New Zealand mainstream-school-based randomized controlled study of remote microphone hearing aids (frequency modulation) in 6–11-yr-old children with reading delay (Purdy et al, 2009). Pre- versus posttrial ratings showed gains in the children's self-perceptions of classroom listening for the experimental group but not for a control group of children at the same school. Moderate test–retest reliability was evident for a separate small group of children with no reading problems (N = 18) (Spearman's *R*s = 0.63–0.74).

The use of amplification has been investigated in other studies using both educational performance measures and pre- and postintervention questionnaires completed by teachers, students, or parents (Arlinger, 2001; Crandell et al, 2004; 2005; Kreisman et al, 2005; Smaldino and Flexer, 2012). An advantage of using questionnaires completed by the child, parent, and teacher is that one can triangulate the listening behavior of the child in variety of scenarios and determine whether the child and the adults around them have a similar perspective regarding their difficulties. For example, a study of typically developing children and children with suspected APD (Tomlin et al, 2015) compared child (LIFE-UK), parent (Fisher's Auditory Problem Checklist [FAPC; Fisher, 1976]), and teacher (Teacher Evaluation of Auditory Performance [TEAP; Purdy et al, 2002]) questionnaires and found moderate correlations (r = 0.4–0.63), after removing some items from the questionnaires that had low internal reliability. A newly developed questionnaire, the Evaluation of Children's Listening and Processing Skills (ECLiPS) was included in a more recent study by Barry et al (2015) which used four questionnaires to examine the perspective of parents (ECLiPS and FAPC), teachers (TEAP) and children (LIFE). This study also found moderate correlations between the questionnaires (Barry et al, 2015). Both Tomlin et al and Barry et al used a reduced seven-item version of the LIFE-UK. Questionnaire responses from children, parents, and teachers will not necessarily agree with one another; a lack of agreement may simply represent differences in perspective. This could explain why only moderate correlations were observed, or alternatively, this could reflect differences in the specific items and wording of the different questionnaires.

One approach to validation of listening questionnaires is to establish correlations with APD test results, rather than comparing different groups of questionnaire respondents (Moore et al, 2010; Barry et al, 2015). The validity of clinical findings would be questioned if there was a complete lack of agreement between APD test results and parent or teacher perceptions of difficulty (Bishop and McDonald, 2009). Mixed results have been obtained across studies when auditory processing scores and questionnaire responses are compared, which could be due to the variability in participants and differences in APD tests and questionnaires across studies. Tomlin et al (2015) generated a Listening Ability Score based on a factor analysis of the listening questionnaires (LIFE, TEAP, and FAPC) used in their study and found weak-moderate correlations between Listening Ability Scores and performance on several standardized auditory processing tests. Strange et al (2009) found an association between dichotic listening performance and parent FAPC scores (Strange et al, 2009). By contrast, Barry et al (2015) did not find significant correlations between LIFE, TEAP, or FAPC ratings of listening difficulties and APD test results, but three of the ECLiPS factor scores correlated with dichotic listening performance. Some studies have found a lack of agreement between auditory processing results and ratings on the CHAPS (Hutchinson and Mauer, 1999; Wilson et al, 2011).

One reason for a lack of correlation between APD test and questionnaire results could be the range of factors other than auditory processing that influence classroom behavior and school performance, and children with APD could have a range of comorbid difficulties. Reading, language, and attention difficulties can co-occur with APD (Sharma et al, 2009; Gyldenkærne et al, 2014), and it may be difficult to distinguish these different sources of difficulty based on behavioral observations alone. Hence, Wilson et al (2011) recommended that questionnaires such as the CHAPS not be used for screening purposes, but should still be used to identify concerns or challenges in everyday listening environments for children with suspected APD. This approach is consistent with Bishop and McDonald's (2009) recommendation that parent perceptions of children's language skills be combined with standardized language assessments as combining parent perspectives and language assessment results better predicted referral to speech language therapy services than either measure alone.

The purpose of the current study was to obtain reliability and validity data for the LIFE-UK from typically developing children and children with APD and listening concerns, in order to advance knowledge and utility of the LIFE-UK questionnaire. The LIFE-UK version was used in the current study as it included pictures. This has been used previously with New Zealand children

(Purdy et al, 2009), and it was available at the time of data collection (2007–2008) for the current study. There is limited published reliability and validity information for the LIFE-UK, but Purdy et al (2009) found acceptable test–retest reliability, and the young children in that study readily responded to each item and found the pictorial scale easy to use when the items were read out to them.

The first aim of the current study was to investigate whether the LIFE-UK items have a reliable factor structure and to examine internal reliability of the questionnaire. Based on previous study, it was hypothesized that the LIFE-UK would display good internal reliability and factors reflecting listening in easy and more difficult conditions (Purdy et al, 2009). The second aim was to determine whether age and attention would affect LIFE-UK ratings with the hypothesis that perceived listening ability would improve with age as the auditory system develops (Sanes and Woolley, 2011) and ratings of classroom listening may be affected by attention difficulties (Dockrell and Shield, 2012). The third aim was to determine whether LIFE-UK ratings would differ between typically developing children, children with APD, and children with listening difficulties. The fourth aim was to determine whether there is an association between LIFE-UK ratings and behavioral measures of auditory processing.

METHODOLOGY

Participants with Auditory Processing Disorder (APD) and Listening Difficulties (LiD)

Participant characteristics are summarized in Table 1. Sixty children (40 males, 67%) aged 7–12 yr came to the University of Auckland Speech Science research clinic for hearing and auditory-processing assessment. The teachers and/or parents had concerns about the children's listening and therefore suspected APD. These participants were from different schools and from various parts of the city.

Diagnosis of APD was based on results of five behavioral tests that tested a range of auditory processes: Dichotic Digit Test Version 2 (DDT; Musiek, 1983), Frequency Pattern Test (FPT; Noffsinger et al, 1994), Random Gap Detection Test (Keith, 2000), and Masking Level Difference (Sweetow and Reddell, 1978; Aithal et al, 2006) (Sharma et al, 2012). APD was diagnosed, using the ASHA (2005) criteria, when their scores that were 2 standard deviation (SD) below the normative mean (Kelly, 2007) on any two tests or 3 SD below for any one test (ASHA, 2005; Sharma et al, 2009). Forty five of the 60 children met the criteria for an APD diagnosis (hence referred to as APD group); the remaining 15 had listening concerns but performed relatively well on the APD test battery and hence are referred to as the LiD group (Table 1). The APD and LiD groups differed in their performance on the FPT; there were no differences on any other auditory processing tasks (Table 1).

Children in the APD (N = 45) and LiD (N = 15) groups were aged 7.0–12.8 yr (mean = 9.63 yr, SD = 1.44). Auditory sustained attention was tested in all children with suspected APD using the Integrated Visual and Auditory Continuous Performance Test (IVA-CPT) (Sandford and Turner, 1995), and they were also tested using the Test of Nonverbal Intelligence-3rd edition (TONI-3) (Brown et al, 1988). Eighteen (40%) children in the APD group (14 males) and 4 (27%) in the LiD

Table 1. Summary of APD and LiD Participants' Auditory Processing, Attention, Language, and Test of Nonverbal Intelligence-3rd Edition Mean Scores Along with Standard Deviation

	APD (N = 45)		LiD (N = 15)		
	Males (N = 29)	Females (N = 16)	Males (N = 11)	Females (N = 4)	Norm Mean
Age (yr)	10.04 ± 1.42	9.35 ± 1.11	9.12 ± 1.58	9.18 ± 2.07	
FPT (R) (percent correct)	31.82 ± 20.90	36.26 ± 20.18	76.94 ± 26.40	67.43 ± 14.44	*
FPT (L) (percent correct)	31.87 ± 24.62	34.40 ± 16.65	76.85 ± 24.39	67.10 ± 14.66	*
DDT (R) (percent correct)	73.02 ± 14.46	74.13 ± 15.15	82.50 ± 11.57	83.13 ± 7.18	*
DDT (L) (percent correct)	77.24 ± 16.15	82.47 ± 13.66	86.36 ± 10.02	85.0 ± 9.79	*
MLD (dB)	10.24 ± 3.53	10.00 ± 3.88	10.80 ± 3.52	11.75 ± 3.30	†
RGDT (ms)	10.58 ± 3.85	11.44 ± 3.29	11.27 ± 3.60	11.25 ± 3.30	20 msec‡
Attention (standard score)	62.90 ± 41.25	73.88 ± 29.16	91.09 ± 24.30	94.50 ± 26.94	85§
TONI-3 (standard score)	95.49 ± 9.73	100.56 ± 15.78	108.64 ± 16.06	100.75 ± 15.20	85§
Receptive language (standard score)	82.97 ± 15.34	85.06 ± 12.30	86.64 ± 15.72	87.0 ± 16.15	85§

Notes: MLD = Masking Level Difference; RGDT = Random Gap Detection Test; TONI-3 = Test of Nonverbal Intelligence-3rd edition. Norms for FPT, DDT, and MLD are age dependent whereas RGDT has a screening level of 20 msec. Attention, TONI-3, and receptive language have standard scores.

*Kelly (2007)—FPT and DDT have age dependent norms.

†Aithal et al (2006).

‡Keith (2000).

§Standard scores 1 SD below mean.

group (3 males) had scores more than 2 SD below (<70) the normative mean of 100 (±15) and therefore had difficulties with the auditory sustained attention task. Receptive language was evaluated using the Clinical Evaluation of Language Fundamentals-4 (CELF-4) which also has a normative mean standard score of 100 (±15) (Semel et al, 2003). All children had scores higher than the normative cutoff standard score of 80 on the TONI (Table 1).

Control Group Participants

Schools in the Auckland area were approached by the researchers and invited to participate in the study. The Control group of 83 children (34 males, 41%) was recruited from nine classrooms from four schools. The Control children were aged 7.4–12.9 yr (mean = 9.91 yr, SD = 1.33). The age of the Control group did not differ from that of the 60 children with confirmed or suspected APD (APD and LiD groups). Control group children did not have any classroom listening difficulties according to their teachers and parents and therefore were not assessed for auditory processing.

LIFE-UK Student and Teacher Versions

The LIFE-UK questionnaire was completed by all three groups of children and their classroom teachers. The LIFE-UK student version requires the child to rate how easily they are able to hear their teacher in different classroom listening situations (e.g., when there is noise outside the classroom, when the teacher is giving a test). There are two versions, A and B, each of which has the same items but in a different order. All children were randomly assigned to versions A and B of the questionnaire. There are 13 items with pictures illustrating the classroom listening situation described in each question. Listening is rated using a five-point Likert scale ranging from "Always Easy" to "Always Difficult" that includes smiling and frowning faces to rate ease of listening. Numbers from 1 to 5 were assigned to responses, with higher ratings indicating more difficulty with listening. Item 8 (Item 11 in version B) was modified depending on the equipment children were familiar with using in their classrooms. Instead of "the overhead projector," the words "data projector" or "computer" were substituted. The student version was administered in an interview format, with the investigator reading out each question and recording responses. Children with APD completed the questionnaire when they were being assessed in the clinic by the second author. Control group participants were withdrawn from the classroom in peer groups to complete the LIFE-UK questionnaire by the third author. Assistance was given to children who had difficulty understanding the questionnaire items. The questionnaire took ~10 min to complete.

The LIFE-UK also has a questionnaire for the teacher to rate the child's listening abilities. This consists of 13 questions with a rating scale from Very Good to Very Poor. Higher ratings indicate that the child has more difficulty with listening. There is a section in the form in which teachers are invited to make written comments about the child's classroom listening. Nine teachers of the Control group children were given only the first page of the teacher questionnaire with the rating scale. They were not asked to make other observations about listening difficulties as the children in the Control group were selected to not have listening difficulties. It was difficult to obtain questionnaire data from all the APD/LiD group teachers. By contrast, all nine Control group teachers returned questionnaires. The difference in response rate between the teachers is likely to be attributable to the researcher meeting each Control group teacher at the time of data collection, but this was not possible for teachers of the APD/LiD groups as the teachers were at many different schools. Teacher ratings were available for all Control group children. Only 28 of the 60 (47%) teachers of the APD and LiD children returned the LIFE-UK.

Ethical Approval

Ethical approval for the study was obtained from the University of Auckland Human Participants Ethics Committee. Informed consent was gained from the principal and participating classroom teachers at each school and from parents/caregivers of each child participant. Children completed an assent form prior to participating.

Data Analysis and Variables

Statistical analyses were conducted using Statistica© version 7.0 (StatSoft, Inc). Factor analysis using varimax normalization was performed on the LIFE-UK data. Internal reliability of items was determined using Cronbach's alpha. Nonparametric Friedman analysis of variance (ANOVA) and Wilcoxon Matched Pairs tests were used to compare results across factors. Age effects on LIFE-UK ratings were examined using Spearman correlations. Comparisons of Control, APD and LiD group LIFE-UK ratings were undertaken for overall scale means and factors using Kruskal–Wallis One-way ANOVA and pairwise group comparisons were undertaken using Mann–Whitney *U*-tests.

Teacher and student LIFE-UK and APD and attention test results were compared using Spearman correlations. In order to reveal trends in the data, there were no corrections for multiple comparisons.

RESULTS

One of the research aims was to determine age effects on questionnaire results (participants were

aged 7–12 yr). This was determined using Spearman correlations. Age was not correlated with student or teacher LIFE-UK ratings ($p > 0.05$), and hence, age was not included in any further analyses.

LIFE-UK Student Version: Factor and Item Reliability Analysis

Three factors accounting for 60% of the overall variance in the Control group children's LIFE-UK ratings emerged from the factor analysis of the 13 items. Six items had factor loadings below 0.65 (Table 2). After excluding these six items, the remaining seven items formed three factors accounting for 71.8% of the variance. These were named to describe the listening conditions suggested by the individual items they included (Table 2). Factor 1, Listening in Noise, included three items (5, 9, and 11) and accounted for 38.5% of the variance; Factor 2, Listening in Quiet, included two items (2 and 10) and accounted for 17.9% of the variance; and Factor 3, Focused Listening, consisted of two items (7 and 13) and accounted for 15.5% of the variance.

Cronbach's alpha for the original 13 items in the LIFE-UK was 0.87 (standardized α value = 0.83), indicating good internal reliability for the original questionnaire. Interitem reliability ranged from 0.34 to 0.76 for the 13 scale items. Cronbach's alpha for the reduced set of seven items was lower but still acceptable (α = 0.72). Interitem reliability ranged from 0.44 to 0.61 for the seven items in the shortened seven-item scale. This indicates moderately good internal reliability for the seven factor items with factor loadings >0.65.

Factor analysis undertaken for the student LIFE-UK ratings from APD and LiD children showed similar findings to the Control group, but with some differences in the specific items. Three factors accounting for 66.3% of the variance. Items with factor loadings >0.65 were as follows: Factor 1 (items 1, 5, and 11; listening in noise), Factor 2 (2 and 13; listening in quiet and school assembly), and Factor 3 (8 and 10; teacher talking with computer on and teacher giving a test), accounting for 47.2%, 10.2%, and 8.8% of the variance, respectively.

LIFE-UK Teacher Version: Factor and Item Reliability Analysis

Reliability and factor analysis was only undertaken for the combined APD and LiD children. These questionnaires were completed by 28 different teachers, whereas Control group data were from only 9 teachers. Cronbach's alpha for teacher LIFE-UK items 1–11 (see mean ratings in Table 3) was 0.92 (standardized α value = 0.92). Interitem reliability values ranged from 0.53 to 0.80. Items 12 and 13 were not included as these ask the teachers to rate classroom noise levels, rather than the child. Factor analysis revealed three factors accounting for 77.8% of the variance (Table 4). Factor 1 items (55.0% of variance) relate to the child attending to directions or a task, Factor 2 items relate to class participation (13.6% of variance). The grouping of Factor 3 items (9.2% of variance) is less clear as the two items rate how well the child attends to multimedia and follows individual directions.

Group Differences for Student and Teacher LIFE-UK Ratings

There were group differences for child and teacher LIFE-UK ratings. Kruskal–Wallis ANOVAs comparing Control, APD, and LiD groups showed significant group differences for each "student" LIFE-UK measure: 13 items: H (2, N = 143) = 21.24, $p < 0.0001$; 7 items: H (2, N = 143) = 23.61, $p < 0.0001$; Factor 1: H (2, N = 143) = 16.12, $p = 0.0003$; Factor 2: H (2, N = 143) = 36.46, $p < 0.0001$; Factor 3: H (2, N = 143) = 11.93,

Table 2. Summary of Student LIFE-UK Items, Inclusion/Exclusion in Factors (Based on Factor Loadings above/below 0.65) and Mean Ratings for Control Group Participants

Item	Description	Factor	Factor Loading	Control 13-item Mean (SD)
1	Traffic or noise outside the classroom	—	—	2.08 (1.33)
2	Quiet day, no noise from outside the classroom	2	0.82	1.13 (0.89)
3	Teacher speaking while class is tidying up	—	—	2.04 (0.46)
4	Teacher talking but cannot see her face	—	—	1.95 (0.88)
5	Teacher talking, noise outside the classroom	1	0.81	2.44 (0.97)
6	Teacher talking, movement and talking from children	—	—	2.18 (1.04)
7	Teacher asks question to whole class. One person answering	3	0.72	1.65 (1.01)
8	Teacher talking and electronic equipment is on	—	—	1.54 (0.69)
9	Teacher is talking and moving around the room	1	0.83	1.70 (0.79)
10	Teacher is giving a test to the whole class	2	0.72	1.34 (0.92)
11	Two teachers talking, trying to listen to one of them	1	0.66	2.30 (0.59)
12	Other children are talking during group activities	—	—	1.93 (1.07)
13	In assembly	3	0.69	1.55 (0.78)

Note: (N = 83).

Table 3. Means (Standard Deviations) for Control, APD, and LiD Groups for the Overall Child Seven-Item Mean and for Teacher LIFE-UK Overall Ratings (Questions 1–11)

	Group	Sample Size	Mean (SD)	Median (IQR 25–75%)	Min–Max
Child	APD	45	2.34	2.43	1.00–3.71
			(0.75)	(1.86–2.86)	
SEVEN-ITEM MEAN	LiD	15	2.36	2.14	1.00–4.29
			(0.87)	(1.71–2.71)	
	Control	83	1.73	1.57	1.00–2.86
			(0.51)	(1.28–2)	
Teacher	APD	21	3.37	3.44	1.33–4.56
			(0.69)	(3.11–3.28)	
Questions 1–11 mean	LiD	7	3.83	3.67	3.00–3.78
			(0.63)	(3.52–4.18)	
	Control	9	2.17	2.09	1.00–4.27
			(0.90)	(1.41–3.00)	

$p = 0.0026$. As illustrated in Figure 1, children in the APD and LiD groups had higher mean ratings than the Control group, indicating greater self-perception of classroom listening difficulty. Mann–Whitney *U*-tests showed that the APD group's ratings (Factor 1 = 2.79 ± 1.01; Factor 2 = 1.83 ± 0.63; and Factor 3 = 2.17 ± 0.95) were ranked significantly poorer (higher ratings) than the Control group (Factor 1 = 2.14 ± 0.83; Factor 2 = 1.23 ± 0.46; and Factor 3 = 1.60 ± 0.59) for all three factors ($p \leq 0.0013$) (Figure 1). The LiD group was ranked significantly poorer than the Control group for Factor 1 ($p = 0.0093$) and Factor 2 ($p = 0.0036$) but not Factor 3 (Factor 1 = 2.87 ± 1.04; Factor 2 = 1.87 ± 0.81; and Factor 3 = 2.10 ± 1.11). Student LIFE-UK ratings did not differ between APD and LiD groups for any factor or for the overall ratings.

Due to the poor teacher response rate, there were relatively few LIFE-UK teacher ratings available for children in the APD (N = 21, 47% of the group) and LiD (N = 7, 47% of the group) groups. Table 3 includes average teacher ratings (means and medians) for the three groups. Overall teacher ratings were based on items 1–11, as items 12 and 13 in the teacher LIFE-UK ask teachers to rate noise levels. Overall LIFE-UK teacher ratings for the combined APD and LiD groups were significantly poorer than Control group teacher ratings ($U = 295.0$, $z = 5.89$, $p < 0.0001$).

Correlation between Teacher and Student LIFE-UK Ratings: Spearman Rank Order correlations comparing overall seven-item child ratings and teacher ratings (11 items) were performed for the combined groups and for each group separately (Table 3). There was a statistically significant, but weak, association (Rs = 0.37, n = 111, $p < 0.05$) between teacher and child LIFE-UK ratings for the combined three groups (Figure 2). There were no correlations when Control (Rs = 0.14, n = 83, $p > 0.05$), and the combined APD and LiD group (Rs = 0.35, n = 45, $p > 0.05$) data were analyzed separately, which could reflect a lack of statistical power.

Table 4. Summary of Teacher Completed LIFE-UK Questionnaire Items, Description, Inclusion/Exclusion in Factors (Factor Loading>/< 0.65) and Mean Scores for Combined APD (n = 21) and LiD (n = 7) Groups

Item	Description	Factor	Factor Loading	APD and LiD Groups' Mean (SD)
1	Following class directions	1	0.74	2.95 (1.33)
2	Following individual directions	3	0.87	1.77 (0.02)
3	Overall attention span	1	0.86	2.52 (1.27)
4	On-task behavior	1	0.87	2.70 (1.17)
5	Rate of learning (speed of following instruction)	—	—	3.18 (1.37)
6	Involvement in class discussions (volunteers more, makes appropriate contributions)	2	0.79	2.80 (1.22)
7	Contributes when working in a group	2	0.78	2.03 (0.98)
8	Paying attention to multimedia (e.g., video, overhead projector)	3	0.79	2.05 (1.14)
9	Willingness to answer questions	2	0.81	2.23 (0.99)
10	Answering questions in an appropriate and relevant manner	2	0.87	1.92 (0.90)
11	Amount of repair behavior (this refers to asking questions, to teacher or peer, in order to clarify what is required)	—	—	3.02 (1.35)

Note: SDs are shown in parentheses. Factor loadings >0.65 are listed.

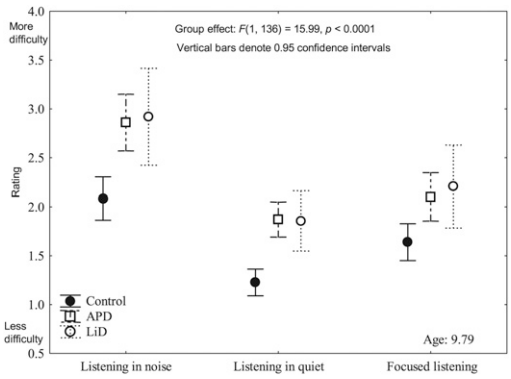

Figure 1. Mean LIFE-UK ratings for the three factors in the children's questionnaire, for Control (n = 83; filled dot), APD (n = 45; empty box), and LiD (n = 15; empty circle) groups. There were significant group effects: APD and LiD had similar ratings, whereas the Control group showed lower ratings for all three factors.

Questionnaires versus Auditory Processing and Attention Difficulties

Audiological measures used to diagnose APD in the clinical groups were compared with the student (seven-item) and teacher 11-item LIFE-UK ratings. FPT and DDT scores were averaged across right and left ears. A weak negative correlation (Spearman rank order correlation) was found between FPT and child LIFE-UK scores (Rs = −0.32, n = 45, $p < 0.05$). Thus, higher LIFE-UK ratings (more difficult listening) were associated with lower (i.e., poorer) auditory processing ability as measured on the FPT. There were no other significant correlations between APD measures and LIFE-UK results. As p values were not corrected for multiple comparisons, the weak correlations with audiological test results may be Type I errors. Further research is needed to confirm these findings.

Mann–Whitney U-tests were undertaken to compare questionnaire results for the children in the APD group with (n = 27) and without (n = 18) attention concerns (IVA-CPT standard scores <85). There were significant differences in student LIFE-UK ratings for 13-item scores ($U = 132.5, z = -2.56, p = 0.0105$), 7-item scores ($U = 128.5, z = -2.65, p = 0.0080$), Factor 1 (listening in noise) and Factor 3 (focused listening) ($U = 124.0, z = -2.76$, $p = 0.0058$ and $U = 144.0, z = -2.29, p = 0.0218$, respectively), whereas Factor 2 (listening in quiet) showed no difference between children with APD with and without attention problems. There were also no differences in teacher LIFE-UK ratings for children with APD with and without co-occurring attention difficulties.

DISCUSSION

The main aim of this study was to investigate the item reliability and validity of student and teacher LIFE-UK questionnaires. Validity was determined by

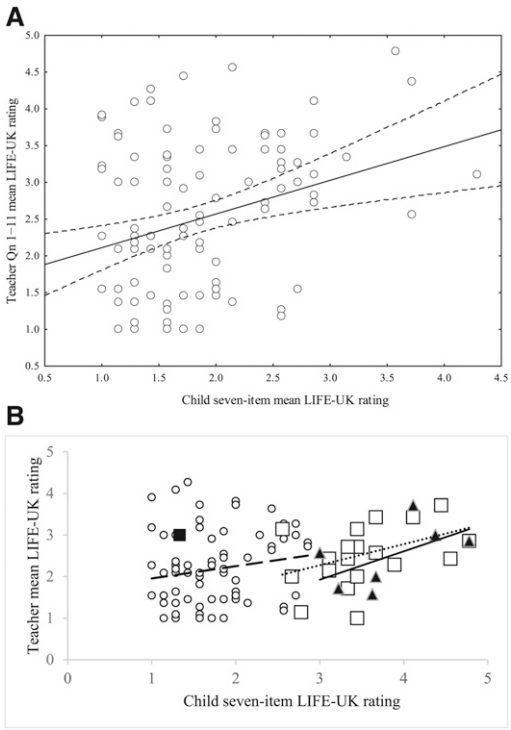

Figure 2. Scatterplot graph showing correlation between teacher (Questions 1–11) and child ratings (seven-item mean) for (A) All (n = 111) participants for the LIFE-UK questionnaire (28 teachers completed LIFE-UK for the APD/LiD children; nine teachers completed LIFE-UK for the 83 Control group children), and (B) the three groups separately (one child with APD, shown as a solid square on the figure, was an outlier—they rated their listening as good but the teacher reported listening problems in the classroom; the result is not included in the APD regression line).

investigating whether LIFE-UK ratings differed between Control children and children with diagnosed and suspected APD, and by comparing ratings with APD test scores. Factor analysis was undertaken as it was hypothesized that this would yield a separation of questionnaire items into different listening situations.

The factor analysis for the Control group student LIFE-UK resulted in questionnaire item groupings that accounted for a large proportion of the variance in questionnaire responses. The first grouping of items, Factor 1, involved listening situations in which the child needed to attend to the speaker while he or she was moving around, or in the presence of noise from both inside and outside the classroom. This factor was named "Listening in Noise." The second grouping, Factor 2, involved listening situations in which there was little or no background noise. This factor was therefore termed "Listening in Quiet." The items in the third grouping were less obviously related, but appeared to involve situations in which it was necessary to focus on one person speaking at a time (individual children answering questions in class or one person speaking at assembly). Presumably, the listener would need to change focus from one speaker to another and filter

out any background noise. Factor 3 was therefore termed "Focused Listening."

The questionnaires in the teacher version of the LIFE-UK do not directly relate to the student version and are focused on measuring benefits of interventions such as classroom amplification (Canning, 1999). The factor analysis of these items related in groupings that related to attention (Factor 1: following class directions, attention span, and on task behavior), class participation (Factor 2: involvement in class discussion, contribution to group, willingness to answer questions, and relevant answers), and self-driven listening behavior (Factor 3: following individual directions and paying attention to multimedia). Item and scale reliability (measured using Cronbach's alpha) were good for both teacher and student questionnaires as a whole, but less satisfactory for individual factors, indicating that further work is needed to establish reliable factors for the teacher and student LIFE-UK questionnaires. Interestingly, student LIFE-UK factor structure differed for Control versus the combined group of APD/LiD children, indicating that children with auditory processing problems may perceive classroom activities that involve listening in a different way to typically developing children. It was not possible to do this comparison of factor structure between Control and APD/LiD groups for the teacher questionnaire, as only nine teachers rated the Control group children whereas 28 teachers completed the teacher questionnaire for the APD/LiD groups. Hence, factor analysis was only undertaken for the teacher ratings of the children in APD/LiD groups.

A shortened seven-item version of the student LIFE-UK was derived with good scale reliability. Six of the 13 student LIFE-UK items were excluded from the shortened version as they did not load on any of the three factors. This shortened version may have more acceptability for clinical use because of its brevity. Self-report ratings for the three factors from the seven-item student LIFE-UK factors were significantly different from each other, indicating that the three factors measure different aspects of listening at school. Factor analysis allows for the use of the most appropriate questionnaire items for classroom listening in noise or quiet and/or focused listening. Interventions such as classroom amplification would be expected to have a greater or lesser effect on these different aspects of classroom listening. Specific information could be gathered regarding the benefits of interventions by examining responses to items for the different factors (e.g., listening in noise and focused listening), as well examining overall ratings.

A previous New Zealand study investigating personal frequency modulation systems for children with reading delay (Purdy et al, 2009) also undertook factor analysis of student LIFE-UK responses, but using a smaller sample and younger children, some of whom had reading difficulties. This earlier analysis also revealed a factor concerning difficult listening situations (Factor 1). This factor included items 5 and 9, in common with the current study's Factor 1, however, it excluded item 11. Item 11 was included in another factor termed "spatial listening" by Purdy et al (2009). Item 11 concerns a situation in which two teachers are in the classroom, standing in different places, and the child is trying to focus on what one of the teachers is saying. There was further overlap of the factor items in the two studies, with Factor 2 in the current study, "listening in quiet" (items 2 and 10) similar to "listening in quiet" in the earlier study (items 2, 3, and 10). Items in Factor 3 from the current study, "focused listening," did not overlap with any of the earlier study factors, with item 7 included in "spatial listening" and item 13 included in "difficult listening." It is difficult to compare these two factor analyses, as the current study used stricter factor loadings of 0.65, whereas Purdy et al (2009) accepted factor loadings of 0.50. Sample sizes were also different. The similarity in the groupings of items into factors, particularly for Factor 1, supports the factor analysis derived with the current sample; however, further research is needed to confirm the factor structure of the shortened LIFE-UK questionnaire.

Age had no effect on LIFE-UK performance, and this was confirmed for both Control and APD/LiD children. This is useful for clinical applications of the LIFE-UK questionnaire in children in the age group of the study participants (7–12 yr). There is substantial evidence showing that children with a diagnosis of APD have different listening characteristics to their typically developing peers (Smoski et al, 1992; Putter-Katz et al, 2002; Moore, 2012). As expected, there was a statistically significant difference between the Control group and APD/LiD group LIFE-UK results; however, the APD and LiD groups did not differ for any of the questionnaires. Not surprisingly, children in both APD and LiD groups rated themselves as having more difficulties with classroom listening than those in the Control group (Figure 1). One limitation of this research is that children in the APD and LiD groups may have had heightened awareness of their listening difficulties as they had been through extensive testing for APD that the Control group did not undergo; this could have biased the children's and teachers' ratings. Although the children in the LiD group did not meet the ASHA (2005) diagnostic criteria for APD, they did present for auditory processing assessment because their families and/or teachers suspected APD. These children may have had difficulties such as poor spatial listening (Cameron and Dillon, 2007) which were not assessed. The lack of difference in APD/LiD questionnaire results supports the validity of the LIFE-UK as a measure of functional classroom difficulties, and supports the recommendation (Wilson et al, 2011) that questionnaires should not be used for diagnosis of APD. When LIFE-UK ratings were compared for the APD/LiD children with and without attention concerns (based on the IVA-CPT scores), there were significant differences. This suggests that the LIFE-UK is

sensitive to functional difficulties associated with both auditory processing and attention difficulties.

Nine teachers provided teacher ratings for the 83 control group participants. For the APD and LiD groups, 28 different teachers provided ratings for 28 individual students (out of 60 in the APD and LiD groups) including 15 participants from the LiD group. Teacher ratings revealed significant differences between the Control and APD and LiD groups. This indicates that the LIFE-UK teacher questionnaire is sensitive to differences in listening performance between children with suspected and diagnosed APD and their typically developing peers. None of the teacher participants were blinded; however, hence the teachers' awareness of the children's diagnosis could have biased responses for the APD group. It is not known whether the parents of the children in the LiD group had shared the outcome of the APD testing prior to the teacher completing the LIFE-UK questionnaire.

A positive correlation between teacher and child ratings on the LIFE-UK was hypothesized. Teacher and child LIFE-UK ratings were weakly correlated when the three groups were combined, but not when the groups were examined separately. A possible explanation for the weak association between teacher and child ratings may be the differences in format and content between the teacher and student versions of the LIFE-UK. Teachers are asked to judge whether particular listening behaviors are of concern for an individual child, whereas children are asked to rate their own abilities in specific listening situations. The questionnaire items therefore relate to listening and learning behaviors (teachers) versus different listening situations (children). Although they encompass related constructs, they are not measuring exactly the same thing. This highlights the importance of indicating whether the student or teacher version of the LIFE is being used. The children and teachers could also have different perspectives of their listening difficulties, as was illustrated by the outlier in the APD group (Figure 2B).

The current study had a small number of Control group teachers (N = 9), and it is possible that the results are not representative of all classroom teachers, as they agreed to complete 83 questionnaires between them and hence were very supportive of the research. Future research with the teacher version of the LIFE-UK should evaluate interrater and intrarated reliability as this has not yet been reported in the literature. A limitation of the data gathered from the Control group teachers and children is that this was a convenience sample of the children with no listening difficulties from schools willing to participate in the research. Ideally standardization of a questionnaire or other assessment should be based on a random sample from the population of interest, rather than selecting children with no known difficulties. This would have increased the chances of finding a difference between the Control group and the APD/LiD groups.

LIFE-UK self-ratings were only weakly correlated with scores for one test (LIFE-UK scores and FPT). More difficult listening was associated with poorer auditory processing ability as measured on the FPT. Although there is a link between these two measures, there is also considerable variability. The coefficient of determination (r^2) was only 0.073. This indicates that only 7.3% of the variance is accounted for by the relationship between these two variables and thus 92.7% of the variance is due to other factors (Pring, 2005). A likely explanation for the low correlation is that the LIFE-UK and APD tests measure different constructs. Another possible reason for lack of correlation is the limited variability in the data. If the control group had completed APD assessments, correlations between measured ability on APD tests and reported difficulty may have been observed. Barry et al (2015) found correlations between three of the ECLiPS factors and dichotic listening (DDT) performance (Barry et al, 2015). The ECLiPS was completed by parents, which correlated with DDT scores. In general, more research is needed with larger numbers to compare parent, teacher, and child perspectives on functional difficulties associated with specific auditory processing difficulties.

SUMMARY

The abbreviated seven-item LIFE questionnaire could be used as a quick, easy-to-administer tool to screen children who self-report classroom listening difficulties, and who may benefit from APD assessment. The questionnaire could be used by audiologists and speech language pathologists to promote awareness among teachers of children's listening difficulties. Factor analysis resulted in the separation of LIFE-UK questionnaire items into three factors (Listening in Noise, Listening in Quiet, and Focused Listening). Both the original 13-item LIFE-UK questionnaire and the shortened seven item 3-factor version had good internal reliability. Despite the limited number of responses from the APD/LiD group teachers, with a possible response bias due to lack of blinding, the teacher version of the questionnaire was sensitive to group differences between children who were diagnosed with APD, children in the LiD group who self-reported difficulties, and children with no listening or learning concerns. The weak correlation between teacher and child ratings on the LIFE-UK may be due to differences in the items in the teacher and child versions of the questionnaire or may reflect differences in child–teacher perspectives or low teacher awareness of the participants' classroom listening difficulties.

Acknowledgments. We thank all the school principals, classroom teachers, students, and parents who gave their time to participate in this study. We wish to acknowledge the work of

Dr. David Canning in developing the questionnaire and for allowing the use of the LIFE-UK version via the hear2learn website.

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