The Parents' Evaluation of Aural/Oral Performance of Children (PEACH) Rating Scale in Chinese: Normative Data

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The Parents' Evaluation of Aural/Oral Performance of Children (PEACH) Rating Scale in Chinese: Normative Data

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Abstract

Objective: This study was to establish Chinese norms of Parent's Evaluation of Aural/Oral of Children (PEACH) rating scale, and to investigate the test-retest reliability and validity for this adapted version.

Design: The PEACH scores were collected from parents whose children have normal hearing. The test-retest reliability of the PEACH scale was evaluated in a subgroup of parents. Correlation analysis was used to explore the relationship between the PEACH ratings and language scores.

Study sample: A total of 198 parents participated in the present study, of whom 34 parents completed the questionnaire twice within 1-3 weeks, and another 27 parents also filled out a language questionnaire.

Results: The normative curve of the total score was established using a logit regression function. The test-retest analyses showed high reliability for all subscales, with all the correlation coefficients values exceeding 0.9 ($p<0.01$). The 90% and 95% confidence intervals were provided to facilitate evaluation of differences between scores obtained under different conditions. A significant correlation was found between the PEACH total score and language expressive outcome ($p < 0.05$).

Conclusions: Normative data from the Chinese population was provided to enable performance of an individual child to be related to their normally hearing peers.

Zhang, PEACH norms

Key words:

Pediatric, Parents' Evaluation of Aural/Oral Performance of Children, Questionnaire, Normative data

Abbreviations:

ABEL: Auditory Behaviour in Everyday Life

CI: Critical interval

FAPI: Functional Auditory Performance Indicators

HL: Hearing loss

IT-MAIS: Infant-toddler Meaningful auditory integrated scale

MCDI: Macarthur-Bates Communicative Development Inventory

MAIS: Meaningful auditory integrated scale

NH: Normal hearing

PCDI: Putonghua Communicative Development Inventory

PCHL: Permanent childhood hearing loss

PEACH: Parents' Evaluation of Aural/oral Performance of Children

UNHS: Universal Newborn Hearing Screening

Introduction

The widespread implementation of Universal Newborn Hearing Screening (UNHS) in China has made it possible for early identification and amplification of children with hearing loss (HL) soon after birth. This creates a significant need of reliable and validated measures that can be used in Chinese clinics to evaluate young children's auditory performance and systematically track their auditory development over time.

As parents usually spend much of their time with their children in a variety of environments during their infancy and early childhood, a standardized parent questionnaire is recognized as a valuable tool to evaluate and monitor children's auditory performance in everyday life (Boudreau, 2005). Internationally, there are few questionnaires which have been widely used in English as outcome measures of auditory behavioural performance for children of different ages and degrees of HL, e.g. A parental questionnaire to evaluate children's Auditory Behaviour in Everyday Life (ABEL; Purdy et al., 2002); Parent's Evaluation of Aural/Oral of Children (PEACH; Ching et al., 2008; Ching & Hill, 2007), Meaningful Auditory Integration Scale (MAIS; Robbins et al., 1991); Infant-toddler Meaningful Auditory Integration Scale (IT-MAIS; Zimmerman-Phillips et al., 2000); Functional Auditory Performance Indicators (FAPI; Stredler-Brown & Johnson, 2004); the LittlEARS Auditory Questionnaire(Coninx et al., 2009). However, the functional performance tools with available normative data are very limited in China (Chen et al., 2010; Zheng et al., 2009). Hence, this is necessary to introduce a valid and reliable tool and publish information of norms to support auditory rehabilitation in clinics.

Compared to the other functional performance tools that were developed for assessing auditory function for children with profound HL (e.g., MAIS, IT-MAIS), or the

questionnaires that are used for infants younger than two years of age (e.g. IT-MAIS, LittlEARS), the PEACH questionnaire, as one of the popular auditory functional performance tools, can be used to evaluate functional performance and monitor auditory development for children from infancy through school age with normal hearing (NH) and with HL ranging from mild to profound degrees (Ching et al., 2008; Ching & Hill, 2007).

The PEACH questionnaire has been translated into several languages and has normative data published in English, Swedish, Malay, and Spanish languages (Bagatto & Scollie, 2013; Brännström et al., 2014; Bravo-Torres et al., 2020; Ching & Hill, 2007; Quar et al., 2012). Previous studies demonstrated that this caregiver-report questionnaire has been well validated and shown to have good test-retest reliability, high internal consistency (Ching & Hill, 2007; Quar et al., 2012), as well as significant correlations with objective measures (Golding et al., 2007) and children's language and psychosocial outcomes (Ching et al., 2013; Ching, Crowe, et al., 2010; Wong et al., 2018). Therefore, it has been routinely used in many countries as a standard clinical tool for assessing functional auditory performance and evaluating the effectiveness of amplification for infants and children with HL in different listening situations (Bagatto et al., 2011; Ching et al., 2008; King, 2010; Quar et al., 2012).

This questionnaire is available in a diary and a rating scale forms which were developed based on a systematic report of parents' observations of children's performance in real-world environments (Ching & Hill, 2007). Both formats have the same scenarios that address quiet and noisy situations in real world environments as well as hearing device usage and loudness discomfort. Compared to the PEACH Diary form, the PEACH Rating Scale does not require caregivers' observation for one week or to provide examples of their child's listening experiences. The scale version was designed to be completed by the caregiver during an appointment with guidance from the clinician, which has been accepted by clinicians and

caregivers because it reduces the respondent burden and administration time (Moodie et al., 2011; personal communication with audiologist at Beijing Tongren Hospital). The previous studies indicated that the normative data collected with the PEACH Rating Scale (Bagatto & Scollie, 2013; Brännström et al., 2014) has similar age-related trends published for the PEACH diary version (Ching & Hill, 2007; Quar et al., 2012). The validation findings support the wide use of PEACH Rating Scale in clinical practice.

As the PEACH rating scale is quick and easy to administer, it is more suited to the fast-paced clinic practices in China. The aims of this study were to adapt the PEACH rating scale into Chinese; to establish the relationship between age and PEACH rating scores of normal-hearing children who are speakers of Mandarin Chinese; and to investigate the test-retest reliability and validity of the adapted Chinese version.

Method

Translation of PEACH Rating Scale into Chinese

The English version of the PEACH Rating Scale was translated into Chinese. The translation was reviewed by two audiologists who are native speakers of Mandarin Chinese. Minor modifications on questions and examples were made in the translated version to ensure the content maintain the original meaning and also suit the particular culture. Subsequent to that, this Chinese version was translated back into English by a third party, who is well-versed in both languages to review the consistency and accuracy of the translation. Next, a native English speaker reviewed the reverse translation and the original English version to ensure that there were no significant differences between them. This person was informed as to the purpose of the translation but was not familiar with the questionnaire. No further modifications were made to the Chinese version. After that, three parents read the final Chinese version and confirmed that the content is easy to understand. Therefore, the final

translated Chinese PEACH scale (*https://www.outcomes.nal.gov.au/peach)* was used for collecting data in this study.

Participants

The PEACH Rating Scale was administered to caregivers of 198 normal hearing children aged from 1 to 113 months (mean= 48.96 months, SD= 35.7) in Beijing, China. Figure 1 shows the age distribution of the children. All children had passed their UNHS on both ears with no risk factors for hearing or neurologic impairment, and no known history of ear or hearing problems. Informed consent was obtained from the child's parent/guardian and the study was approved by the Human Research Ethics Committee.

< Figure 1>

Administering the PEACH rating scale

The PEACH Rating Scale consists of 12 items. The first two items related to the use of amplification and loudness discomfort were not included in this study because they are inappropriate for normal hearing children. Administration of the PEACH scale required 10-15 minutes in total. Two audiologists were responsible for administering the PEACH Rating Scale. They followed the PEACH Rating Scale instructions and guided the parents/carers to recall how often they observed their child's auditory behaviour over the last week in real-life situations and independently rate each item on a 5-point scale with the following descriptions: Never (0%), Seldom (1-25%), Sometimes (26-50%), Often (51-75%), and Always (76-100%). After the rating scale was completed, the audiologist reviewed the form to make sure no items were blank and clarified any unclear items with caregivers. The questionnaires were scored in the same way as described in original English PEACH scale (Ching & Hill, 2007). The scores for all 10 items (items 3 to 12) were summed to give a total score, and also grouped into two subscale scores for quiet (sum of ratings for items 3, 5, 7, 9, and 11) and

noisy listening conditions (sum of ratings for items 4, 6, 8, 10, and 12). The scores were then converted into percentage scores by dividing by the whole scale or for each subscale. Because the PEACH scale has been designed for use with infants as well as school-aged children, caregivers of young infants were asked to provide age appropriate responses.

Experiment of test-retest reliability

To examine the reliability of caregivers' observation of their child's listening behaviour, a subgroup of parents (n=34) participated in a repeatability test and completed the PEACH Rating Scale twice within 1-3 weeks of the first administration of the form. The same parent of each child served as the observer for this test-test experiment.

Validity of the PEACH scale

The PEACH ratings were compared with the children's language performance in a subgroup of parents, by using the short forms of the Chinese version of the Macarthur-Bates Communicative Development Inventory (PCDI) questionnaire (Tardif et al., 2008). The PCDI questionnaire is a parent report instrument which is adapted from the Macarthur-Bates Communicative Development Inventory (MCDI) (Fenson et al., 2000). It consists of two forms: one is the Words and Gestures (W&G) form for infants aged from 8 to 16 months, and the other is the Words and Sentences (W&S) form for toddlers aged from 16 to 30 months. The infant short form (W&G) contains a 106-word checklist with separate columns for vocabulary comprehension and expression. The toddler short form (W&S) contains a 113-word checklist which measures vocabulary expression only. The subgroup sample consisted of 13 children tested on the W&G short form, and 14 children tested on the W&S short form. Each short form generally takes 10-15 minutes to complete and 10–15 minutes to score. Using the PCDI manual [derived from the Appendix E: Percentile rank tables for PCDI short

forms] (Tardif et al., 2008), the PCDI raw scores of children were converted to percentile values.

Statistical analysis

The statistical analysis was performed using IBM SPSS statistics for windows version 26 software. To examine the relationship between the PEACH total score and children's age in month, the PEACH percentage scores were arcsine transformed before statistical analysis, and a logit function was fitted to the data by using a least squares procedure to minimize errors. Test-retest correlation coefficients were calculated to provide information about the reliability. To further evaluate the significance of difference between two scores from the same individual, 90% and 95% confidence interval values were computed by using the standard deviation of test-retest difference. Given the small number of children (n=13) that used the infant short form (W&G) which includes the vocabulary comprehension scale, the language performance in this study was only reported by PCDI expression scale which includes 27 respondents from both the W&G and W&G forms. The validity was assessed through the correlation between the PEACH ratings and PCDI expressive scores. Two-sided p-values <0.05 were considered to indicate statistical significance.

Results

Normal Regression

The PEACH total scores of NH children as a function of age in month is shown in figure 2. The score was best fit with the logit regression function (Equation 1) which accounted for 82.6% of the total variance.

$$y = 100 \times (\sin((2.667 \times \exp(-0.976 + 0.194 * x))/(2 \times (1 + \exp(-0.976 + 0.194 * x))))^2 \quad (1)$$

where x = age in month; y = PEACH total score.

< Figure 2>

The result on the fitted regression line shows that the total score rises rapidly with increasing age. A plateau starts from 22 months with the PEACH score reaching 90% and achieves the maximum score of 95% by 47 months of age. This means on average that maximum PEACH total score can be observed between two and about four years of age for NH children. The previous norms from Australian children and Malaysian children also suggest a similar finding, where the logistic function reached asymptotic scores by around 40 months of age (Ching & Hill, 2007; Quar et al., 2012).

Test-retest reliability

Table 1 shows the average test-retest results and the test-retest differences for the total PEACH score and subscale scores (n=34). The mean test-retest difference was very small, ranging from 0.6 for the Quiet subscale to 0.3 for the Noise subscale. The high correlation coefficients values for the total score ($\alpha = 0.98$, $r = 0.96$, $p < 0.01$) and for both quiet and noise subscale scores ($p < 0.01$) suggests that the PEACH Rating Scale has high test-retest reliability within the age range.

Table 1 also provides the 90% and 95% confidence interval (CI) values of the mean test-retest score differences for total score and subscale scores. A 90% or 95% CI indicates that the probability of the examinee's true score falling outside the CI is less than 10% or 5% respectively. This information can be useful in clinical practice to evaluate the significance of a difference between two scores from two children or from the same individual obtained under different conditions (e.g., different hearing aid prescriptions, different hearing devices). For example, if we observe a difference between two PEACH total scores exceeds the 90% critical difference of 6.5, we are 90% confident to conclude that it is a real difference between the two tested conditions, although there would still be a 10% probability that the obtained difference occurred by chance.

<Table 1>

Validation of the PEACH

There were 27 children (aged from 8-30 months) whose parents completed both PEACH and PCDI questionnaires. Figure 3 shows the relationship between the age-corrected total PEACH scores (i.e. residual PEACH scores) and the percentile values for PCDI expressive scores. The results revealed significant correlations between the two scores ($r = 0.42$, $p < 0.05$). It suggests that children who had better functional auditory performance, as observed by parents, also had higher vocabulary expressive skills.

<Figure 3>

Discussion

The English version of the PEACH has been routinely used as an essential clinical tool in paediatric program management (King, 2010). The normative data of the Chinese PEACH rating scale shows similar trend with the previous studies in other languages (Bagatto & Scollie, 2013; Brännström et al., 2014; Bravo-Torres et al., 2020; Ching & Hill, 2007; Quar et al., 2012), which suggests that PEACH norms are consistent and can be applicable to be used in different languages and cultures environments. The Chinese PEACH scale fills a great need in China for an efficient clinical tool to monitor and assess children's functional auditory performance in everyday life.

Clinical implication

The PEACH scale has a number of clinical applications, which would support auditory rehabilitation in clinics for Chinese population to provide a valuable way of tracking individual intervention progress over time, counselling the parents, setting treatment goals, determining options for the rehabilitation program and evaluating the effectiveness of amplification. The normative data (figure 2) of the total score can be used as a reference to

monitor the auditory development of children over time, so that children who are at risk could be identified early. The Quiet and Noise subscales reveal the auditory performance in different real-world environments, which is also helpful to plan appropriate intervention, e.g. to indicate whether alternative devices or signal-processing strategies may need to be implemented to meet specific listening needs of the child. In addition, the normal range between the +/-2SD can be used as a benchmark to define a realistic expectation of individual PEACH scores. By combining with other testing battery, the PEACH scale can be used to identify a child who may be at risk of listening problems. For instance, if a child's PEACH scores are below the 2SD range of NH peers, it should be prioritised for referral for a follow-up diagnostic hearing assessment and/or treatment.

In addition, a confidence interval for the difference between two means of the PEACH scores can be used in clinical practice to evaluate the effectiveness of amplification or to compare the performance in different amplification conditions. For example, by comparing the PEACH scores achieved by the same child under two hearing conditions (e.g. unaided vs aided; cochlear implants vs. hearing aids; NAL vs DSL prescriptions; monaural vs. binaural configurations; two different hearing device processing technologies; or other variables) (Ching et al., 2016; Ching, Scollie, et al., 2010; Zhang et al., 2014), the clinicians can demonstrate benefits of certain intervention methods. In this application, it is important to ensure that the two scores are observed within 1-3 weeks period for the scores to be valid.

Last but not the least, the significant positive correlation between Chinese PEACH and language expressive ability as depicted by the PCDI score provides evidence on validity of using PEACH scale to assess children's aural/oral communication ability in real life. Previous studies also demonstrate that on average, children who had higher PEACH scores

would have better language results, and the early PEACH results is one of significant predicting factors to reflect a child's later outcomes on speech perception (Ching et al., 2018), language and psychosocial development (Ching, Crowe, et al., 2010; Wong et al., 2018). The evidence lends support to a systematic use of PEACH to evaluate communicative and global psychosocial function of Chinese children in real life.

Feedback from users

An informal investigation into the experiences and perspectives of families and clinicians also contributes to enhancing uptake and acceptability of the PEACH scale. Comments from people who have completed the Chinese PEACH scale clearly demonstrate the usefulness of PEACH scale for monitoring auditory behaviours, management of hearing loss, or complementing other information. For example, one parent said, "*The questionnaire helps me to pay attention to my child's auditory performance in different quiet and noisy environments*." One comment from an audiologist stated, "*PEACH can be used for both young and older children which is really good. The PEACH questions involve more advanced auditory skills. For me, I would use PEACH before or after hearing devices."* Other comments from audiologists included, *"the PEACH questionnaire really helps parents and myself to keep a track of children's auditory performance. It can be a good training for the parents to learn to be proactive, which is considered an important part in the family-centered early intervention," "Using PEACH is surely complementing other audiological information, especially important for the management of infants with auditory neuropathy spectrum disorder," "Useful in providing parents "evidence" of the child's performance in real life situations, which would help them make decision on amplification."* and *"PEACH is definitely a good tool to demonstrate if the hearing aids amplificant is appropriate. This*

could speed up the cochlear implant referral for children with severe to profound hearing loss.

Strengths, Limitations and Future Directions

The PEACH scale is a quick and reliable clinical method to evaluate auditory functional performance in Chinese children from birth to 9 years old, and it has the potential to expand the capacity of current hearing service care in China. The availability of confidence intervals also provides alternative way to identify hearing problems and evaluate amplification outcomes.

The present study is limited in that a small number of parents of infants (n=13) completed the PCDI infant questionnaires (W&G form). This has affected the validity of the correlation between the PEACH scores and language comprehension performance.

The Chinese PEACH scale will be used to monitor auditory development, evaluate amplification, and assist in auditory management of children with hearing loss in Chinese clinics. To facilitate a rapidly emerging trend of mobile health, future work will also focus on developing an application on smartphone to provide an alternative opportunity for hearing service model that may enhance uptake and acceptability of this clinical tool.

Conclusions

This study established Chinese normative data of the PEACH rating scale. The findings support the use of the PEACH rating scale to monitor the development of the auditory behaviour in Chinese children, and to assess an individual child's everyday functional

performance by relating to their normal hearing peers. Further clinical use of this rating scale for children with hearing loss is warranted in Chinese clinical practice.

Acknowledgements and Declaration of Interest

Conflicts of interest

The authors declare no conflict of interest.

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Zhang, Chinese PEACH norms

Table 1. Mean test and retest scores and standard deviations (SD) as well as means and standard deviations (SD) of test-retest differences for the PEACH (n=34). The 90% and 95% critical difference (CD) values and confidence intervals (CI) of the means of test-retest differences are given.

Scale	Test Mean	Test SD	Retest Mean	Retest SD	Test-retest Mean	Test-retest SD	Cronbach's α	Correlation	90% CD (CI)	95% CD (CI)
Total	85.4	11.4	85.8	11.8	-0.4	3.8	0.98	r = 0.96, $p < 0.01$	4.6 (-5.1, 4.2)	5.5 (-6.0, 5.1)
Quiet	87.1	11.9	87.6	11.7	-0.6	5.9	0.95	r = 0.91, p < 0.01	4.7 (-5.3, 4.1)	5.6 (-6.2, 5.0)
Noise	83.7	12.2	84.0	12.7	-0.3	3.5	0.99	r = 0.97, $p < 0.01$	5.0 (-5.3, 4.7)	5.9 (-6.2, 5.6)

Figure legends

Figure 1. The distribution of age of children with normal hearing.

Figure 2. Total PEACH score of normal hearing children as a function of age. Open circles are the percentage of PEACH total scores (y axis) plotted by age in months (x axis). The solid line represents the regression curve using a logit function from the present study (equation 1), and the broken lines denote +/- 2 standard deviations.

Figure 3. Relation of age-corrected PEACH total scores (%) and percentile value of PCDI expressive scores.

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Figure 1.

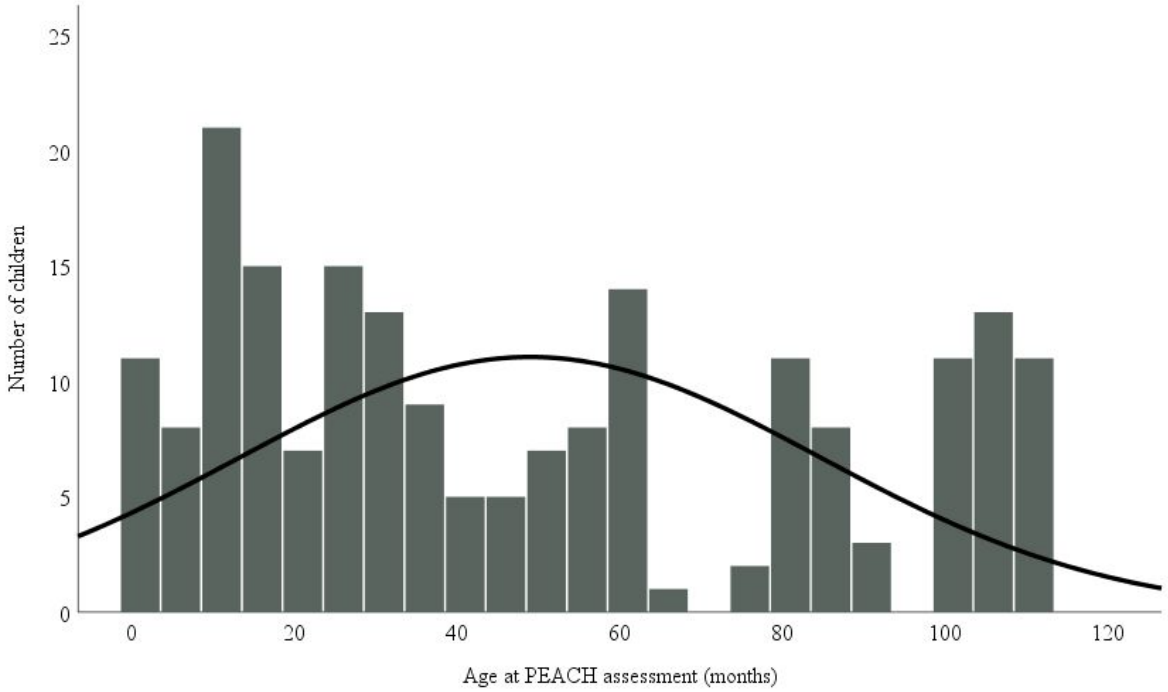

Figure 2.

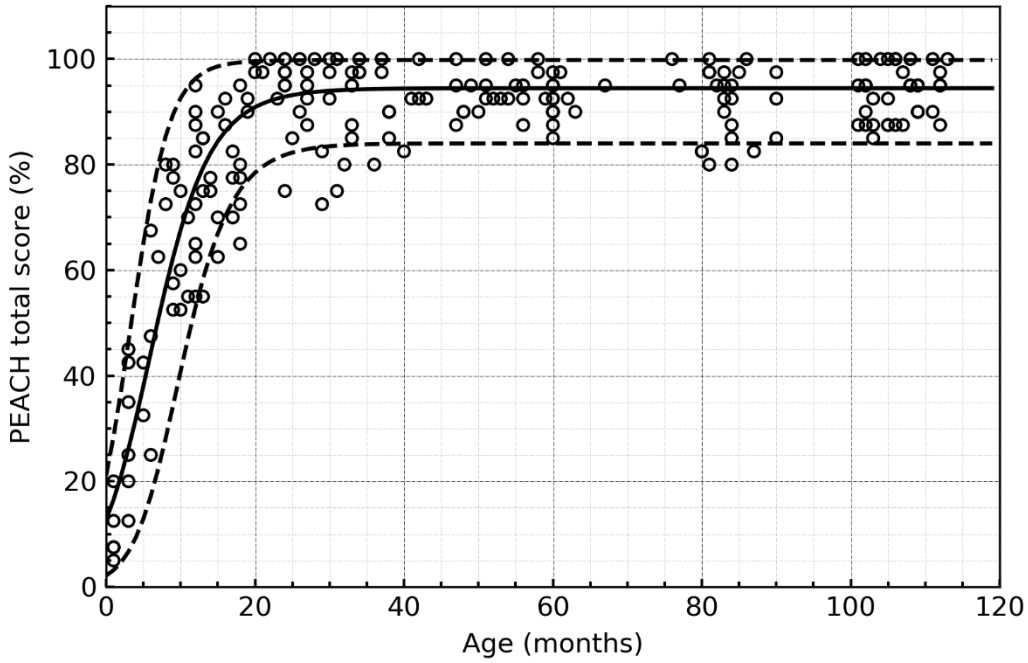

Figure 3.