Assessment of Egyptian children who stutter using the standardized Arabic form of the Test of Childhood Stuttering

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Introduction

Stuttering is one of the most common speech disorders affecting children. The proper assessment of stuttering has been a point of interest for researchers over the years. The aim of this study was to adapt the Test of Childhood Stuttering (TOCS) to suit the Egyptian culture and to test the validity and reliability of application of this test for the assessment of Egyptian children who stutter, for proper management of this ailment.

Patients

This study included 130 children. The ages ranged between 4 years and 12 years 11 months among both boys and girls. The children were divided into two groups: group 1 included 30 children who stuttered; group 2 included 100 typically developing children as the control group, who did not suffer from any language or speech disorder.

Methods

A pilot study was conducted on eight children who stuttered, after Arabic translation of the TOCS, and a few modifications were made to the pictures of the picture book of the TOCS to suit the Egyptian culture. Reliability was assessed by the test–retest method, and test validity was established on the basis of content description validity, internal consistency validity, convergent validity, and known group comparisons.

Results

The Arabic version of the TOCS is a valid and reliable test for the evaluation of Arabic speaking children who stutter and to determine the severity of a child’s stuttering. The results were highly significant and were capable of discriminating between children with normal disfluency and those who stutter.

Keywords:
Arabic language, assessment, stuttering

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Aim of the work

The aim of this study was to adapt the TOCS to suit the Egyptian culture and to assess its validity and reliability in assessing Egyptian children who stutter, for proper management of this ailment.

Participants

This study included 130 children attending the Unit of Phoniatrics, in the outpatient clinic of...
Alexandria Main University Hospital, during the year 2013.

All the children were physically fit. Children with acquired stuttering, brain damage, mental retardation, hearing impairment, highly unintelligible speech, psychiatric problems, a history of clinical and subclinical fits, or with any medical condition that seemed to interfere with proper analysis of the patient were excluded. Their age ranged between 4 years and 12 years 11 months. They were divided into two groups: group 1 included 30 children who stuttered; group 2 included 100 typically developing children as the control group, who were not suffering from any language or speech disorder. The pilot study included eight children. The proposed Arabic version of the TOCS was applied to the children of the pilot group to validate the materials used in the test (clear or not, suitable or not, valid to illustrate the item or not).

**Methods**

All studied individuals were subjected to the protocol of assessment of stuttering, which included assessment of stuttering severity using the Stuttering Severity Instrument-3 (SSI-3) [8].

The components of TOCS [7] include the following:

1. The standardized speech fluency measure.
2. Observational rating scales.
3. Supplemental clinical assessment activities.

The reliability of the test was assessed by test–retest after 8–12 days. The validity of the test was assessed on the basis of content description validity, internal consistency validity, convergent validity, and known group comparisons.

Informed written consent for participation in the study was obtained from the parents and/or the legally caring surrogates of the children; in addition, the child’s assent was also obtained.

Data were analyzed using IBM SPSS software package version 20.0 (SPSS Inc., Chicago, Illinois, USA). Comparison between different groups with regard to categorical variables was performed using the c2-test, Monte Carlo correction, or Fisher’s exact test. For normally distributed data, two independent populations were compared using an independent t-test. For abnormally distributed data, the Mann–Whitney test was used to analyze stuttering and normal groups. Correlations between two quantitative and ordinal variables were assessed using Spearman’s coefficient. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy were calculated. A receiver operating characteristic (ROC) curve was plotted to analyze the recommended cutoff; the area under the ROC curve (AUC) denotes the diagnostic performance of the test. An area greater than 50% represents acceptable performance and an area about 100% represents the best performance of the test. Reliability statistics were assessed using the test–retest method (Pearson’s coefficient). Significant test results are quoted as two-tailed probabilities. Significance of the obtained results was judged at the 5% level.

**Results**

**Pilot study**

The pilot study was conducted on eight children who stuttered, after translation of the TOCS to the Arabic language and its modification to suit the Egyptian culture.

1. The modifications made to some of the pictures of the speech fluency task 1, Rapid Picture Naming, are as follows:
   (a) In practice items, we substituted lawn mower with car.
   (b) In the test items, we substituted the following:
   (i) Crab with fish.
   (ii) Rainbow with moon.
   (iii) Stop sign with traffic lights.
   (iv) Dinosaur with elephant.
   (v) Lunch box with travel bag.
   (vi) Snowflake with flower.
   (vii) Ice cube with cube.
   (viii) Kangaroo with lion.
   (ix) Frog with cow.

2. The modifications made to some of the pictures of the speech fluency task 2, Modeled Sentences, are as follows:
   (a) In practice items, we substituted ‘The boy is riding the pig’ with ‘The boy is riding the donkey’.
   (b) In the test items, we substituted ‘The kids are taking a nap’ with ‘The kids are playing slide’.

3. The modification made to some of the pictures of the speech fluency task 3, Structured Conversation, is as follows: we substituted spaceship with airplane and modified the questions related to the picture according to the change.

4. And according to these changes, the pictures of speech fluency task 4, Narration, were changed.
Demographic data

Age
The controls and cases were classified into two age groups:

1. Age group A: from 4 years 0 months to 8 years 5 months.
2. Age group B: from 8 years 6 months to 12 years 11 months.

Statistically, there was an insignificant difference between the case and control groups (Table 1).

Sex
Nearly 80% of the studied population was male. No significant difference was found between cases and controls.

Test of Childhood Stuttering

1. The standardized speech fluency measure:

Table 2 shows the distribution of the studied groups with regard to the results of the standardized speech fluency measure of the TOCS [6,7].

Statistically, there was a highly significant difference between the case and control groups, whereas there was an insignificant difference between groups A and B in the case and control groups.

2. Observational rating scales:
Table 3 shows the distribution of the studied cases with regard to the results of the observational rating scales of the TOCS [7].

Statistically, there was a highly significant difference between the case and control groups, according to the Mann–Whitney test (P<0.001), whereas there was an insignificant difference between groups A and B in both case and control groups.

3. Supplemental clinical assessment activities:
Table 4 shows an insignificant difference between groups A and B in the case and control groups in speech naturalness, average number of units per repetition, speech rate, disfluency duration, stuttering frequency, and associated behaviors.

Standardization study

Reliability
Error due to time sampling refers to the extent to which a Pearson’s test performance is constant over time. It was estimated by the test–retest method. The time laps between testing varied from 6 to 12 days. Test–retest reliability was measured in the pilot study group of eight children. Table 5 shows that all items of the TOCS are highly significant.

Table 1 Age distribution in the two groups

| Age in years | Cases (n = 30) | Controls (n = 100) | Test of significance |
|--------------|---------------|-------------------|---------------------|
|              | [n (%)]       | [n (%)]           |                     |
| Age group A 4–8.5 | 20 (66.7)   | 67 (67.0)         | t_P = 0.973         |
| Age group B >8.5 to <13.0 | 10 (33.3)  | 33 (33.0)         |                     |
| Mean ± SD | 7.34 ± 2.36   | 7.56 ± 2.51       | t_P = 0.666         |
| Median    | 6.31          | 7.40              |                     |

P, P-value for the comparison between case and control groups; t, Student’s t-test.

Table 2 Distribution of the two studied groups according to the standardized speech fluency measure

| Standardized speech fluency measure | Group A (4–8.5 years) (n = 30) | Group B (>8.5 to <13 years) (n = 10) | Total (n = 30) | Group A (4–8.5 years) (n = 67) | Group B (>8.5 to <13 years) (n = 33) | Total (n = 100) | Test of significance between case and control groups (P_MW) |
|------------------------------------|--------------------------------|--------------------------------------|----------------|--------------------------------|--------------------------------------|----------------|----------------------------------------------------------|
| Rapid picture naming               | 5.25 ± 6.77 (0.638)           | 6.0 ± 9.33 (0.550)                   | 5.50 ± 7.56    | 0.06 ± 0.30 (0.219)            | 0.0 ± 0.0 (0.03 ± 0.17)              | 0.04 ± 0.24 | 0.0001*                                                   |
| Modeled sentences                  | 10.35 ± 7.52 (0.550)          | 11.10 ± 5.65 (0.708)                 | 10.60 ± 6.86   | 0.06 ± 0.30 (0.722)            | 0.03 ± 0.17 (0.15 ± 0.54)            | 0.05 ± 0.26 | 0.0001*                                                   |
| Structured conversation            | 15.15 ± 11.57 (0.625)         | 15.70 ± 10.47 (0.741)                | 15.33 ± 11.03  | 0.06 ± 0.30 (0.185)            | 0.03 ± 0.17 (0.13 ± 0.44)            | 0.05 ± 0.26 | 0.0001*                                                   |
| Narration                          | 4.0 ± 2.58 (0.625)            | 4.80 ± 3.22 (0.138)                  | 4.27 ± 2.78    | 0.21 ± 0.64 (0.0001*)          | 0.03 ± 0.17 (0.0001*)                | 0.15 ± 0.54 | 0.0001*                                                   |
| Total score                        | 34.70 ± 26.07 (0.741)         | 37.60 ± 27.03 (0.741)                | 35.67 ± 25.96  | 0.52 ± 1.31 (0.053)            | 0.09 ± 0.52 (0.0001*)                | 0.38 ± 1.13 | 0.0001*                                                   |

Severity [n (%)]

Typical fluency
- Mild 9 (45.0) 3 (30.0) 12 (40.0) 67 (100.0) 33 (100.0) 100 (100.0)
- Moderate 6 (30.0) 5 (50.0) 11 (36.7) 0 0 0
- Severe 5 (25.0) 2 (20.0) 7 (23.3) 0 0 0

P_MC, Monte Carlo test; MW, Mann–Whitney test; *Statistically highly significant at P ≤ 0.0001.
Validity

(1) Content description validity:

Content description validity involves ‘systematic examination of the test content to determine whether it covers a representative sample of the behavior domain to be measured’.

Selection of the test items was revised by two phoniatrists, who checked all the test items. All
relevant items were included, whereas all irrelevant ones were excluded.

(2) Internal consistency validity:
It is a measure of test homogeneity. It is measured by correlating each composite with the total test score using Pearson's correlation.
Table 6 shows correlation between each subscale and the total scale. The test proved to have good internal consistency, as there is significant positive correlation between each subtest score and the TOCS score.

(3) Convergent validity:
It examines the degree to which the test is similar to (converges on) other tests that it theoretically should be similar to. This was done by comparing TOCS with SSI-3:

Figure 1 shows that there was a significant positive correlation between the total TOCS score and SSI-3 in the stuttering group.

(4) Known group comparison:
Comparison of the mean and SD of the control and case groups showed that the score among cases was significantly higher than that among controls on all test items.

Table 7 shows the performance of the two groups on the standardized speech fluency measure of the TOCS in terms of mean and SD.

Table 8 shows the performance of the two groups on the observational rating scales of the TOCS in terms of mean and SD.

Sensitivity and specificity
The ROC curves with the AUCs and their statistical significance were used as an indicator for scale and subscale performances. Statistically significant AUCs denoted performances better than chance (AUC = 0.50), and the greater the AUC, the better was the performance, with a maximum AUC of 1.00 denoting a gold standard like performance.

The cutoff values for diagnosis were identified just for statistically significant AUCs, where the value that maximized both sensitivity and specificity of the scale was chosen. Values above or the same as the identified cutoff values denote case values. The ROC curve was used to obtain cutoff values for the proposed test (Fig. 2).

Obtaining new cutoff values
Table 9 shows the cutoff scores of the total score of speech fluency measure of the TOCS. The test proved to have high sensitivity and specificity at the identified cutoff points ranging up to 7.

Table 5 The children values of the items that patients scored differently on retest

| Different test items                                      | $r$  | $P$     |
|----------------------------------------------------------|------|---------|
| The standardized speech fluency measure                  |      |         |
| Rapid picture naming                                     | 0.984| 0.0001***|
| Modeled sentences                                         | 0.965| 0.0001***|
| Structured conversation                                  | 0.986| 0.0001***|
| Narration                                                 | 0.772| 0.025*  |
| Total scores                                              | 0.979| 0.0001***|
| Severity                                                 | 0.999| 0.0001***|
| Observational rating scales                               |      |         |
| The speech fluency rating scale                           |      |         |
| I                                                         | 0.765| 0.027*  |
| II                                                        | 0.938| 0.001** |
| III                                                       | 0.751| 0.032*  |
| Severity                                                 | 0.745| 0.034*  |
| The disfluency-related consequences rating scale          |      |         |
| I                                                         | 0.883| 0.004***|
| II                                                        | 0.890| 0.003** |
| III                                                       | 0.898| 0.002** |
| Typical consequences                                      | 0.999| 0.001** |

$r$, Pearson’s coefficient; *Statistically significant at $P \leq 0.05$; **Statistically highly significant at $P \leq 0.001$; ***Statistically very highly significant at $P \leq 0.0001$.

Figure 2

Correlation of the TOCS score with SSI-3 in the studied cases. SSI-3, Stuttering Severity Instrument-3; TOCS, Test of Childhood Stuttering.
Discussion

About two-third of the patients in this sample were between 4 and 8 years, as the primary symptoms of developmental stuttering are first observed between the ages of 2 and 4 years, following a period of relatively fluent speech production [6,9]. Data obtained from the University of Illinois Stuttering Research Program revealed that in 65% of the participating children, stuttering onset occurred before the age of 3 years; the figure rose to 85% by 3.5 years of age [9].

Table 6 Correlation between each subtotal with total scale

| Subtotal and total scale | r | P |
|-------------------------|---|---|
| The standardized speech fluency measure | | |
| Rapid naming             | 0.898 | 0.00001* |
| Modeled sentences        | 0.905 | 0.00001* |
| Structured conversation  | 0.956 | 0.00001* |
| Narration                | 0.686 | 0.00001* |
| Observational rating scales | | |
| The speech fluency rating scale | | |
| I                        | 0.930 | 0.00001* |
| II                       | 0.905 | 0.00001* |
| III                      | 0.966 | 0.00001* |
| The disfluency-related consequences rating scale | | |
| I                        | 0.973 | 0.00001* |
| II                       | 0.949 | 0.00001* |
| III                      | 0.979 | 0.00001* |

r, Pearson’s coefficient; *Statistically highly significant at P ≤ 0.00001.

Table 7 Comparison between the two studied groups according to the standardized speech fluency measure

| Standardized speech fluency measure | Cases (n = 30) | Controls (n = 100) | Z  | P    |
|-------------------------------------|---------------|--------------------|----|------|
| Rapid picture naming                | 5.50 ± 7.56   | 0.04 ± 0.24        | 8.670 | 0.0001* |
| Modeled Sentences                   | 10.60 ± 6.86  | 0.05 ± 0.26        | 10.463 | 0.0001* |
| Structured Conversation             | 15.33 ± 11.03 | 0.15 ± 0.54        | 10.313 | 0.0001* |
| Narration                           | 4.27 ± 2.78   | 0.13 ± 0.44        | 9.744  | 0.0001* |
| Total score                         | 35.67 ± 25.96 | 0.38 ± 1.13        | 9.980  | 0.0001* |
| Severity [n (%)]                    |               |                    |     |      |
| Typical fluency                     | 0             | 100 (100.0)        | 11.245 | 0.0001* |
| Mild                                 | 12 (40.0)     | 0                  |     |      |
| Moderate                             | 11 (36.7)     | 0                  |     |      |
| Severe                               | 7 (23.3)      | 0                  |     |      |

Z, Z for Mann–Whitney test; *Statistically highly significant at P ≤ 0.0001.

Table 8 Comparison between the two studied groups according to observational rating scales

| Observational rating scales | Cases (n = 30) | Controls (n = 100) | Test of significance | P    |
|-----------------------------|---------------|--------------------|----------------------|------|
| The speech fluency rating scale | | | | |
| I                          | 13.83 ± 5.48  | 0.30 ± 0.92        | Z = 10.047            | 0.0001* |
| II                         | 12.53 ± 5.0   | 0.19 ± 0.75        | Z = 10.395            | 0.0001* |
| III                        | 13.07 ± 5.34  | 0.14 ± 0.60        | Z = 10.508            | 0.0001* |
| Severity [n (%)]           |               |                    |                      |      |
| Typical fluency            | 2 (6.7)       | 100 (100.0)        | Z = 10.789            | 0.0001* |
| Mild                       | 17 (56.7)     | 0                  |                      |      |
| Moderate                   | 11 (36.7)     | 0                  |                      |      |
| Severe                     | 7 (23.3)      | 0                  |                      |      |
| The disfluency-related consequences rating scale | | | | |
| I                          | 11.83 ± 7.28  | 0.25 ± 0.86        | Z = 9.905             | 0.0001* |
| II                         | 11.47 ± 5.87  | 0.06 ± 0.34        | Z = 10.588            | 0.0001* |
| III                        | 10.73 ± 5.68  | 0.12 ± 0.46        | Z = 10.395            | 0.0001* |
| Consequences [n (%)]       |               |                    |                      |      |
| Typical consequences       | 6 (20.0)      | 100 (100.0)        | P = 98.113            | 0.0001* |
| Greater than typical       | 24 (80.0)     | 0                  |                      |      |

P, P-value for comparing between the two studied groups; Z, Z for; Mann–Whitney test; *Statistically highly significant at P ≤ 0.0001.
The Egyptian Journal of Otolaryngology has reported few or no statistically significant sex differences [6].

The SSI-3 is the most commonly used measure of stuttering severity. The SSI-3 measures the frequency of symptoms, the duration of the three longest symptoms, and physical concomitant behavior and combines them into an overall score [8]. In the current study, there was a highly significant difference between the case and control groups, whereas there was an insignificant difference between groups A and B of both case and control groups. Riley [8] indicated that SSI-3 can be used as part of diagnostic evaluations, can assist in tracking changes in severity during and after treatments, and can be used to validate other assessment instruments. Lewis [11] did not support Riley’s reliability procedures and found that two of the three parameters of SSI-3 failed to satisfy the fundamental requirement for measures of judge agreement. He concluded that SSI-3 scores do not accurately reflect observations of stuttering behaviors. The SSI-3 has the advantage of being the only available standardized measure of stuttering severity.

Reliability of the TOCS was proven to be high by the test–retest method. We investigated test–retest reliability using a group of eight children. These children had all been previously diagnosed with stutters. The time lapse between testing varied from 6 to 12 days. After the testing was completed, the raw scores for each test were correlated. The results indicated highly significant correlations between initial and retest scores, proven statistically by the correlation coefficient ($r$), which ranged from 0.745 to 0.999, hence proving the reliability of the test. This is in concordance with the results of the original test, in which $r$ ranged from 0.86 to 0.91.

Validity of the TOCS was proven on the basis of content description validity, internal consistency validity, convergent validity, and known group comparisons.

Content description validity is the adequacy with which the test items adequately and representatively sample the content area to be measured. It was examined by three phoniatricians to prove that the test measured what it was designed to measure. There was agreement on most test items and disagreement on some items with regard to the formulation of some of the questions; these were changed to be more clear and suitable.

Internal consistency validity, which is a measure of the homogeneity of the test itself, is measured by correcting each composite with the total test scores using Pearson correlation [12]. Significant positive correlation was found between each subtest score and the TOCS total score. The correlation coefficient ($r$) ranged from 0.856 to 0.979.

Convergent validity examines the degree to which a test is similar to tests that it should theoretically be similar to [12]. In this study, some of the test items were compared with SSI-3 [8] to look for correlations; these items have been selected because of the resemblance in the aim of testing between them and similar items in the TOCS. There is a highly significant positive correlation, proven statistically by the correlation coefficient ($r$) of 0.904, between both tests in the total severity scores.

Known group comparison is one way of establishing a test’s validity by studying the performance of different groups of people on the test. Each group’s results should make sense in relation to what is known about the relationship of the test’s content with the group. In the case of TOCS, a measure of speech fluency, a rating scale for speech fluency, and a rating scale for disfluency and its related consequences, one would expect that individuals with identified stuttering would do worse than children with typical fluency. The means for the control group were much lower than those for cases, and all attained a highly significant probability.

In the current study, the sensitivity index reflects the ability of a test to correctly identify individuals who were previously identified as stutters. The specificity index reflects the ability of a test to correctly identify individuals who were not identified as stutters. The positive predictive value reflects the proportion of
individuals who were identified as stutters among all those identified by the measure as having stuttering-related problems.

The results of the TOCS were highly sensitive and specific. The percentage of sensitivity and specificity ranged from 95 to 100% for cutoff scores \( \leq 7 \) of the total score of speech fluency measure of the TOCS, whereas in the original test of TOCS, the percentage of sensitivity and specificity ranged from 79 to 90% for cutoff scores \( \leq 9 \) of the total score of speech fluency measure.

The ROC curve was plotted and the AUC was calculated for the TOCS total score, with an SSI-3 value of 0.986, indicating good discriminatory potential between typical fluency children and children with a stutter. The cutoff score of the total score of speech fluency measure of the TOCS was established at 7 or lower, showing a sensitivity of 100% and a specificity of 95.24%. The cutoff scores at which the sensitivity and specificity were maximum were 7 or lower. A raw score of 7 or higher by any rater is considered to be a high rating for a child to be categorized as a stutterer, and ratings of 6 or lower are considered to represent children with typical fluency.

**Conclusion**

(1) TOCS offer clinicians straightforward and efficient fluency assessment techniques for children between 4 and 12 years of age.

(2) The Arabic version of the TOCS is a valid and reliable test for evaluation of Arabic speaking children with stutters and to determine the severity of a child’s stuttering.

(3) The results were highly significant and were capable of discriminating between children with normal disfluency and those who stutter.

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