The Brazelton Neonatal Behavioral Assessment Scale:
A validity and reliability study in a Turkish sample

Öznur BAŞDAŞ[1],*, Emine ERDEM[1], Ferhan ELMALI[2], Selim KURTOĞLU[3]

[1]Department of Nursing, Faculty of Health Sciences, Erciyes University, Kayseri, Turkey
[2]Department of Biostatistics and Medical Informatics, Faculty of Medicine, İzmir Kâtip Çelebi University, İzmir, Turkey
[3]Department of Pediatric Health and Disease, Memorial Private Hospital, Kayseri, Turkey

Background/aim: The aim of the Brazelton Neonatal Behavioral Assessment Scale (BNBAS) is to gather a comprehensive profile of neonatal functioning by describing the full range of neonatal behavior, including competencies and strengths, as well as difficulties or deviations. This instrument has proved to be of great clinical value by detecting infants at risk for later developmental problems. This work was conducted methodologically with the aim of a Turkish validity and reliability study of the BNBAS.

Materials and methods: The study was conducted in a large tertiary hospital in Turkey. After establishing content and language validity, the BNBAS was applied to 380 newborns aged 1–3 days and test–retest analysis was performed for 60 newborns 52–55 days later in the first phase. The validity and reliability study of the BNBAS included behavior and support subscales, while reflex items were not included.

Results: In the study, 5 items were excluded from the original BNBAS after the factor analysis. Cronbach alpha was found as 0.974 (30 items). The behavior subscale consisted of 23 items and the support subscale consisted of 7 items. Newborns showed good overall tone and activity level and low amounts of irritable behavior.

Conclusion: It may be recommended to use the BNBAS as a valid and reliable measurement tool in neonatal behavioral evaluation by physicians and nurses.

Key words: Brazelton Neonatal Behavioral Assessment Scale, neonatal behavior, newborn

1. Introduction

The survival rate of newborns has increased as a result of the developments in science and technology (1,2). However, this leads newborns to stay in the hospital for a long term in neonatal intensive care units (NICUs) due to various health problems (respiratory, cardiovascular, gastrointestinal, etc.). Neonates, in the transition period to extrauterine life where physiological and behavioral regulations occur, face numerous environmental stimuli (bright light, loud noise, frequent touching, etc.) and stressors like repeating painful procedures in NICUs where they receive care and treatment (3–6). Newborns display symptoms of physical and behavioral stress as a response to stressors they face in this period, when they are not developmentally prepared. Previous studies indicated that there is a relationship between behaviors of neonate and stimulus and the environment (6–9). Therefore, it is important to assess behaviors of newborns in the period of adaptation to extrauterine life (10).

The Brazelton Neonatal Behavioral Assessment Scale (BNBAS) is one of the scales commonly used in evaluation of a newborn's behaviors. The BNBAS was developed in 1973 to assess behaviors of newborns and revised in 1995 (11). The BNBAS was originally designed to be a clinical instrument, and increasingly over the past decade pediatricians, nurses, and other allied health professionals have been using the concepts of the scale in their work with parents. Clinical examination with the BNBAS has been both infant-centered and family-focused. The scale may serve both as a diagnostic screen and as a form of intervention with parents. The scale is applied through observation of a newborn's individual responses to aversive (like reflexes) and nonaversive (like responding sound by turning) stimuli (11). The scale therefore describes the current status of the individual infant's autonomic, motor, state, and social-attentional systems as they interact with each other and become integrated during the neonatal period. By conducting repeated examinations over the first

10 days of life, it is possible to observe four dimensions of functioning in neonatal behavior: physiologic, motor, state, and attentional/interactional. These serial observations reveal how the systems are being integrated over time and how they are affected by environmental factors. Furthermore, this integrative task seems to proceed in a hierarchical fashion, with autonomic regulation preceding motor organization, followed by the task of state regulation and finally social interactive tasks (8,11,12). The BNBAS ensures holistic and systematical assessment of clinical conditions of term and preterm neonates, for caregivers to understand the nature of neonatal behaviors, and comprehensibleness of newborns' behaviors in studies on development (11,12).

In NICUs, team members with the responsibility to protect and promote health, especially nurses who are the primary caregivers, need to understand responses of newborns. However, scales used for assessing behaviors of newborn are considerably limited in Turkey. This study was planned methodologically in order to conduct a Turkish validity and reliability study of the BNBAS, which might be used to assess newborns' behaviors.

2. Materials and methods
The study was conducted in neonatal units providing tertiary treatment and care service. It is recommended to include 5 to 10 people in the sample per each item to conduct a validity and reliability study of the scale (13–15). Other than reflex items, there are 35 items in the BNBAS, consisting of 53 items in total. Therefore, a minimum of 350 newborns were decided to be included in the study. The study was completed with 380 newborns. Sixty newborns were reassessed using the BNBAS with an interval of 52–55 day for test–retest analyses. Newborns whose postnatal age was 1–3 days and gestational age was 37–41 weeks, who could tolerate the food given by enteral route (breastfeeding, bottle, and orogastric feeding), and who were not receiving any analgesic or sedative medications were included in the study. When assessing neonates using the BNBAS, standards such as performing the assessment between two feeding times in a half-dark, quiet room and at 22–27 °C ambient temperature were ensured.

The BNBAS assesses a newborn's competencies across different neurobehavioral areas: autonomic, motor, states, and social orientation (8). It consists of behavior assessment (28 items), reflex assessment (18 items), and support (7 items) subscales. Each item in the behavior assessment subscale is scored between 1 and 9 and it includes habit, social interaction, motor system, organization of state, regulation of state, and autonomous system parts. As the total mean score of the BNBAS increases, the behavior of the newborn is assessed as "good". Higher scores indicate better neonatal neurobehavioral performance. Every item in the reflex assessment dimension evaluating the neurological condition of the newborn is scored from 0 to 3. Reflex items of the scale were not included in the scope of this validity and reliability study. Support items that were added later into the scale were added in order to identify behavior quality and range of ability to behave in weak and high-risk neonates (8).

In order to use the BNBAS, necessary permissions were obtained from the Brazelton Research Institute holding the right for introduction and distribution of the scale, and from the local ethics committee (2011/45) and institutions (2010/491 and 2010/5527) to conduct the study. After verbally informing parents of newborns who would be included in the sample group, the study was conducted with newborns of parents who verbally and in writing agreed to participate in the study. In order to use the BNBAS, one of the researchers (ÖB) participated in training for the Neonatal Behavioral Assessment Scale-NBAS and received a BNBAS Implementer Certificate from the Brazelton Institute (Harvard Medical School, Boston, MA, USA).

The data were evaluated using IBM SPSS Statistics 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were given as unit number (n), percentage (%), mean, standard deviation (SD), minimum (min), and maximum (max) values.

The additivity of BNBAS items was evaluated by item nonadditivity analysis; internal consistency by Cronbach's alpha coefficient and item–total score correlation coefficient; sample sufficiency by the Kaiser–Meyer–Olkin test; factorability by Bartlett's test of sphericity; factor structure by principal component analysis, Kaiser normalization, and varimax rotation method; and reliability by intraclass correlation coefficients.

3. Results
The sample comprised 380 Turkish infants (55.0% males and 45.0% females) born of vaginal delivery (42.4%) and cesarean section (57.6%). Most newborns were full-term (89.2%) and the birth weight ranged from 2570 to 4800 g (3412.7 ± 310.2). The final form of the scale was produced by making translations from English to Turkish and from Turkish to English for language validity. Content validity of the BNBAS was established by receiving the opinions of three nurses specialized in pediatric nursing and two neonatologists, and it was decided that the scale represented the characteristics required to be measured.

As confirmed total correlation values were examined, it was determined that confirmed total correlation values of item 17 - peak arousal point (0.281), item 19 - irritability/discomfort (0.310), item 20 - change of state/lability (0.375), item 27 - change in skin color/lability (0.273), and item 28 - smiling (0.299) were lower than 0.40 and disturbed the factor structure. After excluding items 17,

19, 20, 27, and 28 of the scale, Cronbach's alpha coefficient was determined as 0.974 (Table 1).

In item nonadditivity analysis of the BNBAS, the interitem nonadditivity hypothesis was rejected (P < 0.001) and items in the BNBAS were determined to be discussed over total mean score.

Sample size was sufficient for validity and reliability analysis, items composing the test were compatible with factor analysis, and the measured characteristic was multidimensional in the population where the sample was chosen (Kaiser–Meyer–Olkin values = 0.963, Bartlett values = 11,961.923, and P < 0.001).

In line with analysis results, items receiving loading from subscales of the BNBAS were examined and the BNBAS "Behavior Subscale" consisted of 23 items (items 23, 22, 14, 15, 2, 24, 21, 12, 10, 7, 9, 1, 13, 11, 4, 3, 25, 6, 5, 8, 16, 26, and 18), while the "Support Subscale" consisted of 7 items (items 33, 31, 30, 32, 34, 35, and 29) (Tables 2 and 3). Correlation coefficients of test–retest scores of the BNBAS were determined to be high (P < 0.001) (Table 4).

Table 1. Item analysis of the BNBAS and Cronbach Alpha values calculated when the items are removed.

BNBAS items	Mean ± SD	Min–max	Verified item total correlation	Cronbach alpha values calculated when the items are removed
Item 1. Response dec. to light	7.19 ± 1.30	3–9	0.862	0.972
Item 2. Response dec. to rattle	7.01 ± 1.35	2–9	0.830	0.972
Item 3. Response dec. to bell	6.82 ± 1.36	3–9	0.803	0.972
Item 4. Res. dec. to foot probe	6.65 ± 1.41	2–9	0.808	0.972
Item 5. Animate visual	6.49 ± 1.22	2–9	0.772	0.972
Item 6. Anim. visual and auditory	6.64 ± 1.12	3–9	0.793	0.972
Item 7. Inanimate visual	6.39 ± 1.29	2–9	0.818	0.972
Item 8. Inanim. visual and auditory	6.67 ± 1.09	3–9	0.731	0.973
Item 9. Inanimate auditory	6.55 ± 1.24	3–8	0.833	0.972
Item 10. Animate auditory	6.58 ± 1.30	2–9	0.829	0.972
Item 11. Alertness	6.50 ± 1.18	3–8	0.809	0.972
Item 12. General tone	4.26 ± 1.44	1–6	0.811	0.972
Item 13. Motor maturity	6.73 ± 1.19	3–9	0.820	0.972
Item 14. Pull-to-sit	6.66 ± 1.35	3–9	0.848	0.972
Item 15. Defensive	6.87 ± 1.51	3–9	0.832	0.972
Item 16. Activity level	3.77 ± 1.00	1–5	0.656	0.973
Item 18. Rapidity of build-up	4.48 ± 1.32	1–6	0.589	0.974
Item 21. Cuddliness	6.79 ± 1.29	3–9	0.832	0.972
Item 22. Consolability	6.55 ± 1.24	3–9	0.861	0.972
Item 23. Self-quieting	6.60 ± 1.26	2–8	0.872	0.972
Item 24. Hand-to-mouth	6.79 ± 1.25	2–9	0.845	0.972
Item 25. Tremulousness	5.98 ± 2.15	1–9	0.812	0.973
Item 26. Startles	7.39 ± 1.83	1–9	0.734	0.973
Item 29. Quality of alertness	7.23 ± 1.08	3–9	0.689	0.973
Item 30. Cost of attention	7.21 ± 1.10	3–9	0.601	0.973
Item 31. Examiner facilitation	7.23 ± 0.93	4–9	0.482	0.974
Item 32. General irritability	7.12 ± 0.86	5–9	0.408	0.974
Item 33. Robustness and endurance	7.22 ± 0.86	5–9	0.477	0.974
Item 34. State regulation	7.08 ± 0.89	4–9	0.496	0.974
Item 35. Examiner's emot. resp.	7.33 ± 0.81	4–9	0.403	0.974

Table 2. Factor analysis results (total variance explained).

Factor	Initial eigenvalues			Rotated total of load factor		
	Total	Explained variance %	Cluster %	Total	Explained variance %	Cluster %
1	17.518	58.393	58.393	14.805	49.349	49.349
2	2.444	9.146	67.539	5.157	18.190	67.539

Table 3. After the factor analysis, the transformed components matrix.

BNBAS items	Subdimensions	
	1	2
Item 23. Self-quieting	0.842	0.294
Item 22. Consolability	0.837	0.274
Item 14. Pull-to-sit	0.830	0.262
Item 15. Defensive	0.829	0.231
Item 2. Response dec. to rattle	0.821	0.257
Item 24. Hand-to-mouth	0.821	0.275
Item 21. Cuddliness	0.819	0.257
Item 12. General tone	0.815	0.195
Item 10. Animate auditory	0.815	0.256
Item 7. Inanimate visual	0.804	0.254
Item 9. Animate auditory	0.798	0.298
Item 1. Response dec. to light	0.796	0.373
Item 13. Motor maturity	0.795	0.287
Item 11. Alertness	0.786	0.290
Item 4. Res. dec. to foot probe	0.785	0.286
Item 3. Response dec. to bell	0.785	0.262
Item 25. Tremulousness	0.782	0.279
Item 6. Anim. visual and auditory	0.768	0.290
Item 5. Animate visual	0.765	0.236
Item 8. Inanim. visual and auditory	0.745	0.206
Item 16. Activity level	0.719	0.048
Item 26. Startles	0.688	0.292
Item 18. Rapidity of build-up	0.620	0.072
Item 33. Robustness and endurance	0.167	0.806
Item 31. Examiner facilitation	0.186	0.787
Item 30. Cost of attention	0.321	0.787
Item 32. General irritability	0.112	0.769
Item 34. State regulation	0.272	0.656
Item 35. Examiner's emot. resp.	0.191	0.599
Item 29. Quality of alertness	0.117	0.576

Table 4. Correlation analysis of test repetition scores of the BNBAS.

	Grand total	Factor 1	Factor 2
R grand total	r = 0.978 P < 0.001	r = 0.968 P < 0.001	r = 0.720 P < 0.001
R factor 1	r = 0.967 P < 0.001	r = 0.975 P < 0.001	r = 0.624 P < 0.001
R factor 2	r = 0.759 P < 0.001	r = 0.668 P < 0.001	r = 0.971 P < 0.001

4. Discussion

It is important to understand responses of newborns, who can express themselves only with their behaviors and in a limited way. Valid assessments that are feasible for use in NICUs with fragile newborns are important for early detection and intervention with the ultimate goal of improving neurodevelopmental outcomes (10). Understanding responses of neonates receiving care and treatment in NICUs and planning, applying, and assessing their care accordingly is the responsibility of nurses as the primary caregivers in particular. The BNBAS is a scale developed for holistic and systematical assessment of newborns and ensuring comprehensibleness of newborns' behaviors. The BNBAS includes areas designed to assess infant activity, state and changes of state, general condition, ability of social responding, and responses to visual, auditory, and tactual stimuli.

Two major characteristics that a qualified assessment instrument is required to have are validity and reliability. Validity is the ability of an assessment instrument to measure desired characteristics correctly and precisely; reliability, on the other hand, is the ability of an assessment instrument to measure the characteristics consistently and always in the same way (16–18). As a validity study of the scale, language validity, content validity, and construct validity studies were conducted. In order to determine language validity, the scale was translated and retranslated by academic staff with a good command of both languages

and opinions of an expert were obtained to determine if the translation of the scale corresponded to the expression of the original items or not. It was concluded that the assessment instrument measured the desired characteristics in both languages. Opinions were received from 5 specialists for determining content validity and items of the assessment instrument were decided to have the capability for representing the area of the desired characteristics. Construct validity indicates to what extent an assessment instrument can measure the theoretical structure that it claims to measure (17,19). For determining construct validity, various methods such as factor analysis, component and discriminant validity, comparison of a known group, and testing the hypothesis are used. Factor analysis, one of the commonly applied methods, was used to construct the validity of the BNBAS. Factor analysis is a multivariate statistical method aiming to find new factors/subscales, which are less in number, conceptually significant, based on the correlation between a great number of interrelated scale items measuring the same construct (13,17–20). Accordingly, Kaiser–Meyer–Olkin and Bartlett's test of sphericity values were calculated for the BNBAS. A Kaiser–Meyer–Olkin value of 0.963 and B = 11961.923 were found for the scale (P < 0.001). These results reveal that the sample size was sufficient for validity and reliability analysis, items of the test were compatible with factor analysis, and the measured characteristic was multidimensional in the population from which the sample was chosen.

The sum of squares of factor loadings for each factor is called the eigenvalue coefficient. The eigenvalue coefficient is used in calculating the ratio of variance explained by each factor and in deciding the number of significant factors. As the eigenvalue increases, variance explained by the factor increases and factors with an eigenvalue of 1 are assessed as significant factors (21). In examination of the factor structure of the BNBAS, principal component analysis, Kaiser normalization, and varimax rotation methods were used. Osofsky and O'Connell indicated that several researchers performed factor analysis of the BNBAS or revealed factors/clusters based on individual items to determine the reliability, validity, and predictability of the scale (22). In addition, a data reduction system commonly used for the BNBAS is the seven-item model developed by Lester in 1982 (23–27). Azuma et al. analyzed psychometric characteristics of the seven-item model of Lester and compared it with other data reduction systems. In a study conducted on preterm infants, previous factor studies that were alternatives to Lester's model and 3 models based on clinical experience were developed. As a result of confirmatory factor analysis

and analysis performed using the LISREL VI procedure of maximum likelihood, it was indicated that none of the 4 models were not confirmed. It was suggested in the study that a 2-factor model (orientation and animation) among the 4 models was the most appropriate model (27). Even though factors similar to Lester's model were determined in studies on the BNBAS (23,28), items were determined to have two factors in this study. While the first one of the factors determined in the study explained 58.393% of the total variance, the second one explained 9.146%. The explained total variance amount was 67.539%. Correlation between items and factor is explained by factor loading value (factor coefficient) and factor loading needs to be a minimum of 0.40 for any item to be assumed within the scope of a factor (13). In this direction, items of the scale in terms of factor loadings were as follows: items 23, 22, 14, 15, 2, 24, 21, 12, 10, 7, 9, 1, 13, 11, 4, 3, 25, 6, 5, 8, 16, 26, and 18 were in the first factor and items 33, 31, 30, 32, 34, 35, and 29 were in the second factor. In accordance with analysis results, items receiving loadings from factors of the BNBAS were examined and the first factor consisting of 23 items was named the "Behavior Subscale" and the second factor consisting of 7 items was named the "Support Subscale".

In reliability analysis of the BNBAS, Cronbach's alpha value was determined to be 0.974 (30 items) after excluding items 17, 19, 20, 27, and 28, having confirmed item total correlation values smaller than 0.40, from the scale. This is higher than the Cronbach alpha coefficients found in studies conducted by Costa et al. and Moragas et al. on the BNBAS (23,28). Descriptive characteristics and Cronbach alpha coefficients of the BNBAS based on general total and factors were calculated to be 6.36 ± 1.10 (α = 0.977) for factor 1, 7.20 ± 0.71 (α = 0.876) for factor 2, and 6.56 ± 0.95 (α = 0.974) for the general total of the scale. The test–retest method was used to determine the scale's coefficient of time invariance and correlation coefficients between test–retest scores and scores of the scale were found to be high (P = 0.001). Accordingly, it can be asserted that the reliability of the BNBAS is high.

In this study, the BNBAS, which allows ensures Turkish physicians and nurses to understand responses of newborns and to assess them by performing a systemic examination, was determined to be a valid and reliable scale to be used to assess behaviors of neonates. It can be recommended for physicians and nurses working in neonatal units to evaluate behaviors of newborns regularly and continuously via the BNBAS.

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