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Development and Validation of a Short Version of the Scale for Parent to Baby Emotions (SPBE-20): Conceptual Replication among Pregnant Women in Japan

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Abstract

The Scale for Parent-to-Baby Emotion (SPBE) is a 73-item self-report measure of maternal emotions towards a baby. This study aimed to develop and validate a short version of the SPBE. In Study 1, women with a 1-month-old baby (N = 879) were given a set of questionnaires via a website to create a short version of the scale. In Study 2, we performed explanatory factor analysis (EFA), confirmatory factor analysis (CFA), and measurement invariance of the SPBE short version among 696 women in their 1st trimester. In Study 3, measurement invariance of the short version of the scale between postnatal and prenatal women in Studies 1 and 2 was examined and the subscale scores were linked to the other correlates. In Study 1, the short version (SPBE-20) with 6-basic and 4-self-conscious emotion subscales was developed. In Study 2, the 6-basic emotions model showed acceptable fit: χ^2/df = 4.251, CFI = .951, and RMSEA = .068. The 4-self-conscious emotions model also showed acceptable fit: χ^2/df = 5.508, CFI = .964, and RMSEA = .081. All coefficient omega of subscales were >.59. The 4-self-conscious emotions model showed configural up to factor covariance invariance across parity and age. In Study 3, measurement invariance of the 6-basic emotions model was rejected, whereas the 4-self-conscious emotions model showed metric invariance. The

subscale scores were significantly correlated with depression, obsessive compulsive symptoms, borderline personality traits, and tokophobia ($p < .001$). The SPBE-20 may be used in the perinatal period. Further sophistication of the scale is needed.

Keywords

1. Introduction

Parental emotion towards child (and foetus) underlies parental behaviour and parent-child relationship. A child is a very important other to whom a parent has occasionally strong emotions both positive and negative. Parental emotion is enforced in a situation that is important to either child or parent. One of such a situation is when an infant cries. Infant cries as an attachment behaviour. This is a biological system necessary for survival (Bowlby, 1969). Infant cry elicits strong emotional reactions from parents. Emotions towards infant cry have been studied often in the framework of maternal sensitivity (Leerkes, 2011; Leerkes et al., 2004; 2009; Leerkes & Qu, 2020). However, this is not conceptualized based on theoretical categories of human emotions.

We believe that parental emotions should be defined under the rubrics of human emotions that include both basic and self-conscious emotions. Basic emotions are also biological reactions: emotion expression is a specific reaction by the facial muscle via the central nervous system (Ekman et al., 1983; Ekman, 1989), which are immediate reaction to an external or internal event. On the other hand, interactions with the child make parents conscious of themselves (Ellett & Swenson, 2005; Landgren & Hallström, 2011). Self-conscious emotions differ from basic emotions. Many researchers indicated importance of differentiation of shame and guilt in phenomenology (Harder et al., 1992; Tangney, 1990; 1996; Tangney, Wagner, Fletcher, et al., 1992; Tangney, Wagner, Gramzow, 1992; Tangney et al., 1996; Tangney et al., 1998; Tibbetts, 2003). Pride, also contains two dimensions (alpha pride and beta pride) characterized by distinctive ways of appraising the causes of accomplishments (Tracy et al., 2004; 2007a; 2007b; Tangney, 1990).

We developed the Scale for Parent-to-Baby Emotions (SPBE: Hada et al., 2022), consisting of 73 items of two dimensions: the basic emotions scale with six subscales (Happiness, Anger, Fear, Sadness, Disgust and Surprise) and the self-conscious emotions scale with four subscales (Shame, Guilt, Alpha- and Beta-pride). However, having as many as 73 items, the SPBE is too lengthy. A practical short instrument is essential for both research and clinical situations. Nevertheless, a long form of a psychological measure is often shortened in social sciences without much theoretical consideration (Goetz et al., 2013; Coste et al.,

1997; Kleka & Soroko, 2018; Koǧaer, 2020; Schipolowski et al., 2014). Researchers should present their rationale for short form creation (e.g., Stöber & Joormann, 2001; Marsh et al., 2005). In the present study, we tried to select 20 items from the 73-item SPBE, by considering the following: 1) excluding items with kurtosis > 5.0; 2) selecting two items from respective domains that showed the highest item-total correlations; 3) when two domains were correlated highly with each other, selecting, from the respective domain, a second item that showed the lowest correlation with the scores of the other domain; 4) when procedure 3 failed to select two items that would not produce a theory-driven explanatory factor analysis (EFA) result, selecting two items with the lowest correlations with the other domain; 5) when both procedures 3 and 4 failed to select items that would not produce a theory-driven EFA result, selecting the highest and third highest items in terms of item-total correlations; and 6) when three domains were substantially correlated with each other, we calculated the "total rank" of each item by subtracting the rank of each item in terms of its correlations with the scores of the other domains from the rank of the item in terms of its item-total correlation of the respective domain, and selecting the top two items in terms of the total rank. By using such manoeuvres, we tried to strike a balance between convergent and divergent validities. Another importance of developing a new measure of parental emotions towards a child is to have such characteristics that can be applicable to a wide age range from the foetus through infant to preschool child. The factor structure of the short version of the SPBE should be the same between women after childbirth and pregnant women.

The present report is an endeavour to develop a short instrument that a) has a factor structure of the 6-basic emotions model and the 4-self-conscious emotions model (Study 1), b) is replicable among pregnant women (Study 2), c) has theory-driven associations with the other correlates (Study 2), and d) has measurement invariance between postnatal women and pregnant women (Study 3).

2. Study 1

2.1. Methods

Study procedures and participants

Study 1 was the initial step in the development of the SPBE-short version. We used our previous data to conduct a secondary analysis of selecting items to make a short version. The target was mothers at 1 month after childbirth in this cross-sectional study. The total number of eligible samples was 831. Among them, 426 (51.3%) were nulliparas and 404 (48.9%) were multiparas. The parity of 49 women was not known. The ratio of infants' gender was even: 406 (48.9%) boys and 421 (50.7%) girls. The gender of 52 babies was not known (Hada et al., 2022).

Measurements

The SPBE (Hada et al., 2022) consists of 73 items that came from emotions described with brief phrases with a 5-point rating scale from 1 ("did not feel at

all") to 5 ("felt extremely strong"). These items were presented following the instruction: "How strongly did you feel these emotions when your baby cried the most recently?" The theory-driven 6-basic emotions bifactor model and the 4-self-conscious emotions factor model were judged as the best models. These measurement invariances were indicated across parity and gender differences of the child.

Procedure and data analysis

After calculating mean, SD, skewness, and kurtosis of all the 73 SPBE items, correlations between each item with its scale score (item-total correlation) and other subscales' total scores (**Appendix** **Table A1** and **Table A2**) were calculated. As described in the Introduction, every two items for each of 10 emotion subscales were selected by considering the ranks for item-total correlations (see Results). These 20 items were entered into an EFA. The basic emotion and self-conscious scales were examined separately. We used the whole sample for an EFA ($N = 831$). First, items with skewness > 3.0 or kurtosis > 5.0 were excluded. The Keiser-Meyer-Olkin (KMO) test and Bartlett's sphericity examined the sample's factorability. We adopted the most likelihood method and PROMAX rotation for factor extraction. Then we examined the goodness-of-fit of the 6-basic emotions model and 4 self-conscious emotions model in confirmatory factor analysis (CFA). The model-fit with the data was examined by different indices: χ^2, comparative fit index (CFI), and root mean square of error approximation (RMSEA). A good fit was defined as $\chi^2/df < 2$, CFI > 0.97, and RMSEA < .05. An acceptable fit was defined as $\chi^2/df < 3$, CFI > .95, and RMSEA < .08 (Bentler, 1990; Schermelleh-Engel et al., 2003).

Further, we examined measurement invariance between nulliparae and multiparae, and between the younger (under 34 years old) and elder (34 and older) age groups. Invariance from one step to the next was judged as "accepted (invariance)" if we identified either a) a non-significant increase of χ^2 for df of difference, b) a decrease of CFI < .01, or c) an increase of RMSEA < .015 (Cheng, 2007; Desa, 2014: p. 20). Because of the high sensitivity of χ^2 to the sample size, CFI and RMSEA may be better indicators of judging measurement invariance than χ^2. We used this criterion for judgement to avoid excessive 'rejection' rates.

2.2. Results

The total number of eligible samples was 831 (Hada et al., 2022). Items with skewness > 3.0 or kurtosis > 5.0 were excluded (**Appendix** **Table A1** and **Table A2**). Then, we carefully selected two items each for every domain. We selected the top two ranked Happiness items in terms of item-total correlation (i.e., 03HA and 04HA). The Anger subscale correlated strongly with the Disgust subscale ($r = .83$), therefore we selected one Anger item which was ranked as the highest Anger item-total correlation (i.e., 14AN), and one which was ranked as the lowest correlation with the Disgust total score (i.e., 10AN). For Fear, the top two items of item-total correlation were selected (i.e., 20FE and 22FE). The Sadness subscale correlated strongly with the Anger and Fear subscales (both

r > .70). We rated the rankings of item-total correlation for each Sadness item (the higher the correlation, the higher the ranking) as well as the rankings of correlations with Fear and Disgust total scores for each Sadness item (the lower the correlation, the higher its ranking). We calculated the total rank score (the rank of item-total correlation for the Sadness scale + the rank of correlation with the Fear total + the rank of correlation with the Disgust total), and selected as Sadness items the top two total rank scores (i.e., 26SA and 27SA). For Disgust, as in the selection of the Anger items, we selected one item with the highest item-total correlation for the Disgust subscale (i.e., 30DI), and one which ranked as the lowest correlation with the Anger total score (i.e., 35DI). The Surprise subscale correlated strongly with the Fear subscale, therefore the top two items with the lowest correlation with the Fear total score were selected as the Surprise items (i.e., 39SU and 40SU). For Shame, we selected the top two items with the lowest correlation with the Guilt total score (i.e., 45SH and 48SH). The two items that were ranked the first (i.e., 54GU) and third (i.e., 58GU) for item-total correlations were selected as the Guilt items. A strong correlation was found between the Alpha-pride and Beta-pride subscales (*r* = .87), therefore, we selected the top two items with the lowest correlation with the Beta-pride total score as the Alpha-pride items (i.e., 66ALPHA and 65ALPHA). On the other hand, the top two items with the highest item-total correlation for the Beta-pride subscale were selected as the Beta-pride items (i.e., 68BETA and 70BETA). Thus, each of the 10 emotion subscales finally had two items.

For the 12 items extracted for the basic emotions scale, both the KMO test (.841) and sphericity (χ^2 (*df*) = 3975.883 (66), *p* < .001) showed the adequacy of the data for EFAs. All the factors loaded the two items expected from the theory (Table 1). The CFA of this model-fit with the data was good. For the self-conscious emotions scale, using 8 items, the KMO test (.747) and sphericity (χ^2 (*df*) = 2747.663 (28), *p* < .001) showed the adequacy of the data for EFA. All the factors loaded the two items expected from the theory. Factor I, II, III, and IV represented Beta-pride, Guilt, Shame, and Alpha-pride, respectively (Table 2). CFA of this model-fit with the data was good. All coefficient omega subscale and alpha coefficient were >.65 (Appendix Table A3).

The 6-basic emotions model showed stability as configural, metric, scalar, factor variance, and factor covariance invariance between the younger vs. elder age groups, and configural as well as metric invariances were accepted between nulliparae and multiparae (Appendix Table A4). In the 4-self-conscious emotions model, configural, metric, scalar, factor variance, and factor covariance invariance were accepted between the younger vs. elder age groups; as well, configural and metric invariances showed stability between nulliparae and multiparae (Appendix Table A5). Regarding the factor means of the younger and elder age groups, among the 6-basic emotions model, the factor mean for Anger of the younger group was significantly higher than the elder group; as well, the factor mean for Surprise of the younger group was higher than the elder group. The factor mean of the 4-self-conscious emotions model showed no significant

Table 1. Study 1; EFA for the Basic emotions scale of the SPBE-20 (whole sample; $N = 831$).

Label Contents (abbreviated)	Factor					
	I	II	III	VI	V	VI
03HA enjoy	.02	**.95**	−.01	.09	−0.06	−.01
04HA glad	−.00	**.72**	.01	−.10	0.09	.05
10AN pissed me off	−.04	−.00	**.57**	.28	−0.00	.01
14AN wanted to hurl something	.04	.01	**.90**	−.08	0.00	−.01
20FE anxiety	−.03	.04	.01	−.05	−0.01	**.99**
22FE frustrated	**.39**	−.05	−.05	.05	0.01	**.43**
26SA lonesome	−.03	.03	.00	−.01	**1.04**	−.03
27SA drearily	.15	−.04	.01	.17	**.36**	.10
30DI hated it	−.02	−.05	.07	**.67**	−0.02	.16
35DI troublesome	.01	.03	−.01	**.86**	0.02	−.12
39SU surprised	**.71**	.03	.00	.07	−0.06	−.08
40SU startled	**.79**	−.00	.03	−.09	0.03	−.02

Note. Factor loadings > 0.3 are in bold.

Table 2. Study 1; EFA for the Self-conscious emotions scale of the SPBE-20 (whole sample; $N = 831$).

Label Contents (abbreviated)	factor			
	I	II	III	IV
45SH felt like hiding away	.05	−06	**.95**	.01
48SH felt like escaping	−.08	.19	**.55**	−.00
54GU there was no excuse	−.02	**.59**	.10	−.07
58GU I did something wrong	.04	**.96**	−.05	.05
65ALPHA I was a good mother	**.37**	−.03	.03	**.45**

Continued

66ALPHA competent as a mother	.02	.01	−.01	**.94**
68BETA content with baby care	**.96**	−.02	.01	−.04
70BETA fulfilled in baby care in baby care	**.84**	.05	−.02	−.01

Note. Factor loadings > 0.3 are in bold.

differences between the younger vs. elder groups or between nulliparae and multiparae (**Appendix** Table A6).

2.3. Discussion

Study 1 provided the initial short version of the SPBE (SPBE-20). The twenty items of the SPBE-20 were unambiguously separated into the 6-basic emotions and 4-self-conscious emotions subscales by EFAs and CFAs. The SPBE-20 preserved the construction of the original SPBE (Hada et al., 2022). Comparison between nulliparae and multiparae proved metric invariance but was rejected at the scalar invariance level. However, comparison between younger and elder groups was accepted up to factor covariance invariance. This suggests the stability of the factor structure of the SPBE-20. Younger women were scored higher in Anger and Surprise. With age, individuals reported greater emotional control and lesser negative emotional experience (Gross et al., 1997).

In Study 2, we used the newly developed SPBE-20 with instruction sentences modified for expectant women. Study 2 also examined the scale's construct validity by correlating the subscale scores with the other correlates.

3. Study 2

3.1. Methods

Study procedures and participants

In Study 2, the SPBE-20 was distributed among pregnant women. This was a part of a mental health survey on pregnant women during the COVID-19 pandemic in Japan. A longitudinal study among pregnant women was administered at two time points: Time 1 was when the women were 12 to 15 weeks gestational age, Time 2 was when they were 22 to 25 weeks gestational age. Their mean (SD) age was 31.7 (4.5) years old, and the mean (SD) gestational age was 13.4 (1.1) weeks. For approximately half of the women, the current pregnancy was their first experience. Approximately three-quarters of the women (73.6%) were nulliparae and 26.4% were multiparae.

Web surveys of the two occasions were matched by their e-mail addresses. Participants were recruited for two weeks, from 7 to 21, December, 2020, via an internet application by Luna Luna and Luna Luna Baby (MTI Ltd., Tokyo, Japan). To conduct Time 2 survey, we sent e-mails including information about

Time 2 survey to 696 pregnant women who had participated in Time 1 survey, approximately 10 weeks later. Of those, 245 (35.2%) responded. As an incentive, we gave an online gift card which could be used for Amazon shopping to participants. Participants were assured of anonymity and participation was voluntary.

Measurements

Maternal emotions towards foetus: We used the SPBE-20 developed in Study 1. The anchor point was modified from a 5-point to a 7-point scale. It is of note that the instruction was modified and given as "How strongly did you feel these emotions when you imagined your baby in your womb?"

Depression: We used two items asking the first two symptom items of Major Depressive Episode (MDE): depressed mood and lack of interest. Each item was rated with a 4-point scale. A set of the two questions would predict MDE reasonably well (Bowling, 2005; Chochinov et al., 1997; Cutler et al., 2007; De Boer et al., 2004; Mishina, et al., 2009; Mitchell, 2008; Mitchell & Coyne, 2007; Richardson et al., 2010).

Obsessive compulsive symptoms: We used the Japanese version (Koike et al., 2017) of the Obsessive-Compulsive Inventory-Revised (OCI-R: Foa et al., 2002) for measuring obsessive compulsive symptoms. This consists of 18 items with a 7-point scale. It has six subscales: Washing, Checking, Ordering, Obsessing, Hoarding, and Neutralizing.

Borderline personality traits: We used the short version (Yamada et al., 2022) of the Inventory of Personality Organisation (IPO: Kernberg & Clarkin, 1995) for measuring borderline personality traits. This consists of nine items with a 7-point scale. It has three subscales: Primitive Defence (PD), Identity Diffusion (ID), and Reality Testing (RT) Disturbance.

Tokophobia: We used the Japanese version (Takegata et al., 2017) of the Wijma Delivery Expectancy/Experience Questionnaire (WDEQ: Wijma et al., 1998) for measuring fear of childbirth (tokophobia). This consists of 33 items with a 5-point scale. Higher scores indicate more severe fear of the forthcoming delivery. In this study, item 31 was erroneously deleted.

Procedure and data analysis

The basic emotions (12 items) and self-conscious emotions (8 items) scales were examined separately. After calculating mean, SD, skewness, and kurtosis of each item, the KMO test and Bartlett's sphericity were examined. After confirming the adequacy of the data for EFA, we proceeded to EFAs. We applied the most likelihood method and PROMAX rotation to factor extraction, and used the whole sample for EFAs (*N* = 696). This was started from a single-factor structure model progressing to models with a larger number of factors (i.e., two- and three-factor structures, and so on). The goodness-of-fit of models derived from EFA and theoretical models (i.e., the 6-basic emotions model and the 4-self-conscious emotions model) with the data (*N* = 696) of pregnant women were examined in CFAs. Model comparisons were conducted in a series of CFAs of the basic and self-conscious emotions models derived from EFAs as well as theory-driven models. After selecting the best model for the basic emotions scale

and self-conscious emotions scale, we calculated coefficient omega subscales and alpha coefficients. The coefficient omega is an estimate of the proportion of variance in the unit-weighted total score attributable to all sources of common variance (Reise et al., 2013; Revelle & Zinbarg, 2009; Rodriguez et al., 2016). Further, we examined configural and measurement invariance of these models between nulliparae and multiparae, and between the younger (31 years old and under) and the elder (32 years old and over) age groups. We used the same criteria as in Study 1 to judge invariance.

3.2. Results

Almost all the basic emotions scale items showed skewness < 2.0 and kurtosis < 4.0 (**Appendix** Table A7). Both the KMO test (.863) and sphericity (χ^2 (*df*) = 2638.084 (66), *p* < .001) showed adequacy of the data for EFA. Table 3 describes the results of the 1-, 2-, 3-, and 4-factor models.

Almost all of the self-conscious emotions scale items showed skewness < 2.0 and kurtosis < 4.0 (**Appendix** Table A8). Both the KMO test (.739) and sphericity (χ^2 (*df*) = 2039.428 (28), *p* < .001) showed adequacy of the data for EFA. Table 4 describes the results of the 2-, 3-, and 4-factor models. The 4-factor model was an improper solution.

In the CFAs in the basic emotions scale, we compared the 1-, 2-, and 3-factor models with the 6-basic emotions model (theory-driven model). The 6-basic-emotions model showed the best and acceptable fit (Figure 1, **Appendix** Table A9). In the self-conscious emotions scale, the 1-, 2-, and 3-factor models and 4-self-conscious emotions model (theory driven model) were compared one

Table 3. Study 2 (*N* = 696); EFA for the Basic emotions scale of the SPBE-20.

Variable Name (Full-version's label)	Contents (abbreviated)	1-factor	2-factor		3-factor			4-factor			
		I	I	II	I	II	III	I	II	III	VI
SP11 (03HA)	enjoy	**.30**	−.36	−.13	−.53	.07	−.02	.00	−.13	−.07	−0.42
SP20 (04HA)	glad	**.43**	−.55	−.09	−.68	.02	.02	−.03	.04	.01	−1.01
SP8 (10AN)	pissed me off	**.41**	**.73**	−.19	.17	**.62**	−.13	**.63**	.06	−.11	0.13
SP1 (14AN)	wanted to hurl something	**.43**	**.78**	−.13	**.38**	**.42**	−.09	**.39**	**.41**	−.09	0.01
SP9 (20FE)	anxiety	.25	.18	**.39**	.16	.07	**.37**	.07	.12	**.38**	0.03
SP19 (22FE)	frustrated	**.39**	.17	**.61**	.25	−.01	**.56**	−.02	.23	**.56**	0.03
SP10 (26SA)	lonesome	**.43**	**.63**	−.03	−.22	**.93**	.09	**.90**	−.14	.09	−0.06
SP2 (27SA)	drearily	**.46**	**.62**	.13	.30	**.37**	.15	**.31**	**.40**	.14	−0.05
SP17 (30DI)	hated it	**.45**	**.60**	.10	**.78**	−.05	−.02	−.08	**.74**	−.02	0.09
SP15 (35DI)	troublesome	**.47**	**.66**	.08	**.70**	.07	−.02	−.01	**.85**	−.06	−0.03
SP3 (39SU)	surprised	.19	−.12	**.55**	−.16	.05	**.58**	.05	−.16	**.59**	−0.02
SP16 (40SU)	startled	**.32**	−.01	**.74**	.00	−.08	**.74**	−.07	−.04	**.74**	0.03

Note. Factor loadings > 0.3 are in bold.

Table 4. Study 2 ($N = 696$); EFA for the Self-conscious emotions scale of the SPBE-20.

	Contents (abbreviated)	1-factor	2-factor		3-factor			4-factor			
		I	I	II	I	II	III	I	II	III	VI
SP5 (45SH)	felt like hiding away	.28	**.63**	.13	**.58**	−.06	.08	.04	.09	**.80**	−.09
SP13 (48SH)	felt like escaping	**.37**	**.71**	.03	**.51**	−.24	.01	−.20	.01	**.50**	.06
SP6 (54GU)	there was no excuse	**.40**	**.62**	−.01	**.76**	.10	−.08	.07	−.11	**.45**	.28
SP14 (58GU)	I did something wrong	**.39**	**.67**	.09	**.76**	.06	.02	−.01	.03	−.01	**1.01**
SP7 (65ALPHA)	I was a good mother	**.48**	.14	**.89**	.09	−.04	**.94**	.04	**.75**	.12	−.01
SP4 (66ALPHA)	competent as a mother	**.54**	−.08	**.80**	−.10	.08	**.72**	−.02	**.94**	−.07	.03
SP12 (68BETA)	content with baby care	**.60**	−.53	.21	−.01	**.81**	.03	**.90**	−.00	.05	−.04
SP18 (70BETA)	fulfilled in baby care in baby care	**.60**	−.53	.21	.03	**.93**	−.01	**.84**	.03	−.05	.05

Note. Factor loadings > 0.3 are in bold.

Figure 1. Study 2 ($N = 696$); the 6-Basic emotions model of the SPBE-20 (CFI, comparative fit index; RMSEA, root mean square error of approximation; AIC, Akaike information criteria. Paths are standardised. The names of error variables are deleted.).

by one. The 4-self-conscious emotions model's model-fit with the data was the best and acceptable (Figure 2, Appendix Table A10). All coefficient omega subscales and alpha coefficients were >.59 (Appendix Table A11).

The configural invariance of the 6-basic emotions model was an improper solution. The 4-self-conscious emotions model showed stability as configural, metric, scalar, factor variance, and factor covariance invariance between nulliparae and multiparae, as well as between the younger group and the elder group (Appendix Table A12). The factor mean of Shame showed a significant difference; nulliparae was rated higher than multiparae (Appendix Table A13). All subscale scores of the SPBE were significantly correlated with Depression, OCIR, IPO,

chi-squared=88.122
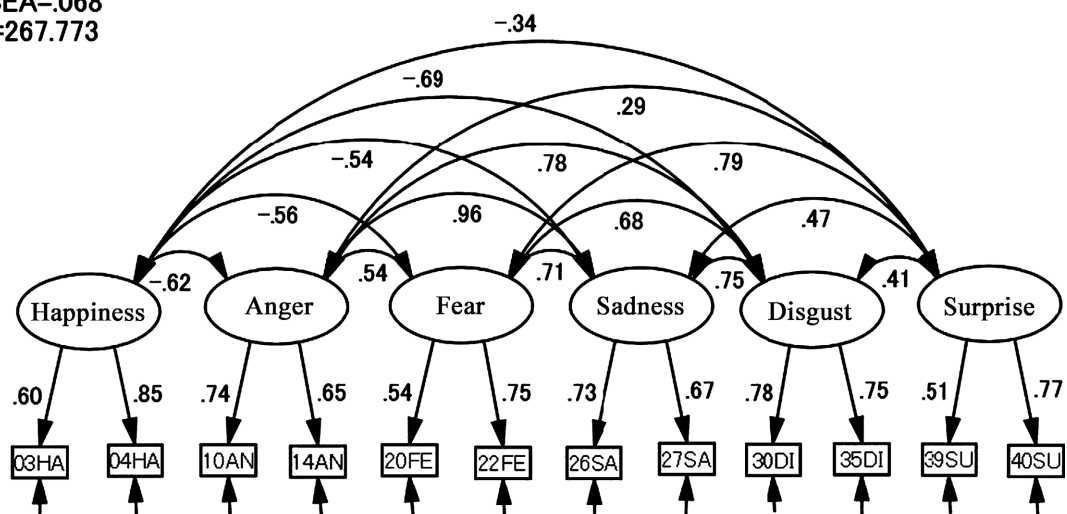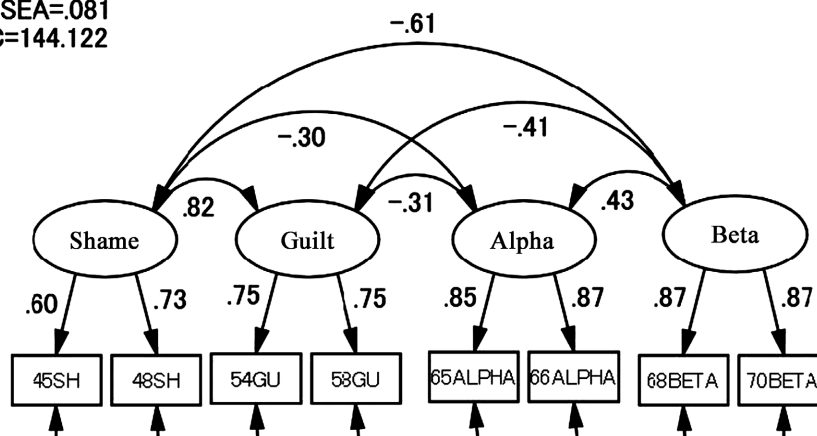df=16
CFI=.964
RMSEA=.081
AIC=144.122

Figure 2. Study 2 ($N = 696$); the 4-Self-conscious emotions model of the SPBE-20 (CFI, comparative fit index; RMSEA, root mean square error of approximation; AIC, Akaike information criteria.Paths are standardised. The names of error variables are deleted.).

and WDEQ scores ($p < .001$) in the expected direction (Table 5).

3.3. Discussion

In the Study 2 CFAs, two theory driven models showed acceptable fit. The parent-to-baby emotions can be explained by the theoretical models of basic and self-conscious emotions (Hada et al., 2021). In addition, internal consistency was good. In this early pregnant woman's sample, whereas measurement invariances of the 6-basic emotions model across parity and age were rejected, factor covariance invariances of the self-conscious emotions model across parity and age were accepted. Self-conscious emotions in the parent-to-baby emotions among pregnant women are likely to be able to be measured as stably as among mothers one month after childbirth. As expected, the positive emotion subscales were correlated negatively while the negative emotion subscales were correlated positively with psychopathological variables such as depression, obsession and compulsion, borderline personality traits, and fear of childbirth.

4. Study 3

Study 3 is the final step in the present study. Measurement invariance across a perinatal period of the SPBE-20 was examined.

4.1. Methods

Study samples

We used both the Study 1 sample as postnatal women ($N = 831$) and Study 2 sample as prenatal women sample ($N = 696$).

Measurement

The Scale for Parent-to-Child Emotion short version (SPBE-20) was used.

Table 5. Subscales' correlation with Depression, OCIR total, IPO total, and WDEQ total (All indices are significant ($p < .001$). Depression, two items of Major Depressive Episode (MDE); OCIR total, total score of the Obsessive Complhensive Inventory Revised; IPO total, the total score of the Inventory personality Organization; WDEQ total, the total score of the Wijma Delivery Expectancy/Experience Questionnaire).

Subscales	Correlation with			
	Depression	OCIR total	IPO total	WDEQ total
basic emotions				
Happiness	−.37	−.18	−.25	−.50
Anger	.30	.21	.27	.38
Fear	.32	.32	.31	.55
Sadness	.37	.29	.35	.45
Disgust	.36	.20	.28	.46
Surprise	.11	.17	.24	.21
self-conscious emotions				
Shame	.42	.30	.35	.50
Guilt	.35	.27	.35	.41
Alpha pride	−.25	−.12	−.21	−.41
Beta pride	−.34	−.16	−.23	−.51

Data analysis

We examined measurement invariance of the 6-basic emotions model and the 4-self-conscious emotions model between postnatal women (Study 1 sample) and pre-natal women (Study 2 sample). Invariance from one step to the next was judged as in Studies 1 and 2.

4.2. Results

In the basic emotions scale, configural invariance of the 6-basic emotions model was rejected between postnatal women and prenatal women. However, in the 4-self-conscious emotions model, configural and metric invariance were accepted between postnatal women and prenatal women (Table 6).

4.3. Discussion

The 6-basic emotions model did not show the invariance between postnatal women and prenatal women. However, configural and metric invariance of the 4-self-conscious emotions model were accepted. Self-conscious parent-to-baby emotions between postnatal women and prenatal women can be measured on the basis of the same construction and the same factor loading. Basic emotions have some characteristics: automatic appraisal, quick onset, brief duration, and unbidden occurrence (Ekman, 1994). Therefore, basic emotions may depend on current external cues and situations. On the other hand, self-conscious emotions' occurrence relates to a sense of 'self' including an ongoing sense of self-awareness

Table 6. Study 3; Measurement invariances of the 4-Self-conscious emotions model the SPBE-20 between postnatal women (N = 831) and Prenatal women (N = 696) (*p < .05; ***p < .001).

	χ^2	df	χ^2/df	$\Delta\chi^2$ (df)	CFI	ΔCFI	RMSEA	ΔRMSEA	Judgfment
Configural	189.750	56	5.930	Ref	.951	Ref	.070	Ref	ACCEPT
Metric	202.369	52	5.621	12.620(4)*	.948	.003	.068	+.002	ACCEPT
Scalar	617.158	44	14.026	414.789(8)***	.822	.126	.113	.045	REJECT

and the capacity for complex self-representations that constitute one's identity (Tracy & Robins, 2004). Self-conscious emotions indicate emotional traits (proneness) rather than an ongoing emotional state; therefore, it is likely to be measured stably and continuously in the same factor structure and construct during the perinatal period.

5. General Discussion

We carefully developed an abridged version of the SPBE (SPBE-20) and expanded the age range of the child from neonate to foetus. In this study, the factor structure of the 6-basic emotions model and the 4-self-conscious emotions model of the SPBE-20 was derived from the data of postnatal women (Study 1), and showed acceptable fit to the data of pregnant women (Study 2). The parent-to-foetus emotions may be measured by using the SPBE among pregnant women. However, the 6-basic emotions model and the 4-self-conscious emotions model did not show sufficient measurement invariance between postnatal women and pregnant women; configural measurement invariance of the 6-basic emotions model was rejected, as well as scalar invariance of the 4-self-conscious emotions model (Study 3). Therefore, SPBE-20 should not be used for comparison between postnatal and pregnant women.

It is important to capture emotions across social and cultural contexts for the selection of items in emotion research (Weidman et al., 2017). The description of the question preceding the items of the SPBE-20 differed between postnatal women and pregnant women. The setting of the situation when they feel these emotions is crucial. Further research is needed for development of the SPBE to be used for bringing out individual differences.

The concept of parental bonding is not necessarily clear. There are authors who narrowly defined bonding as parental love towards a child. Some other authors include under the definition of bonding not only positive emotions such as love and affect but also negative ones such as anger and rejection. Yet another group of authors emphasize the importance of parental sensitivity to a child's cue as well as parental skills. Our study of the SPBE focussed on maternal emotions, both positive and negative, because we believe that maternal emotion is, though leading to underlying motivation, different from care skills. Amalgamation of emotion, cognition, and skills may bias data and analyses (e.g., Postpartum Bonding Questionnaire, Brockington et al., 2001; Maternal Fetal Attachment Scale, Cranley, 1981; Maternal Antenatal Attachment Scale, Condon, 1993;

Maternal Attachment Inventory, Muller & Ferketich, 1993).

6. Conclusion

Maternal emotions towards a child are akin to and may be a core component of maternal bonding to a child. Although the present study is encouraging for clinicians and researchers to use the SPBE during the perinatal period, particularly postnatally, further sophistication of the scale needs to be conducted.

Ethical Considerations

Study 1 was conducted under the approval of the Ethical Committee of Japanese Red Cross College of Nursing (No. 2018-068). Study 2 was conducted under the approval of the Institutional Review Board (IRB) of the Kitamura Institute of Mental Health Tokyo (No. 2020101501). In both studies, all the participants gave written informed consent after understanding the study rationale and procedure. The authors assert that all procedures contributing to this study comply with the ethical standards of the national and international committees on human experimentation and with the Helsinki Declaration of 1975 as revised in 2008. All participants taking part in the study provided informed consent.

Availability of Data and Materials

The datasets used and analyzed in the present study are available from the corresponding author upon reasonable request.

Authors' Contribution

TK, ST, and MI set up the research design. AH and TK collected data. AH and

TK analysed data. AH and TK wrote the manuscript. All the authors checked the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix Tables

Table A1. Mean, SD, skewness, kurtosis item-total correlations for each item of the basic emotions dimension of the SPBE (whole sample; $N = 831$) in Study 1.

label (item No.)	Contents (abbreviated)	Mean	SD	skewness	kurtosis	Item total correlation [rank]					
						Happiness total	Anger total	Fear total	Sadness total	Disgust total	Surprise total
01HA (E2)	happiness	2.92	1.10	0.25	−0.51	.781 [6]	−.169	−.177	−.253	−.324	−.074
02HA (E62)	relieved	1.74	0.94	1.10	0.45	.642 [8]	.080	.140	.050	−.003	.216
03HA (E39)	**enjoy**	**2.31**	**1.14**	**0.56**	**−0.47**	**.822 [2]**	**−.125**	**−.056**	**−.162**	**−.209**	**.027**
04HA (E72)	**glad**	**2.68**	**1.34**	**0.36**	**−0.99**	**.873 [1]**	**−.089**	**−.014**	**−.099**	**−.203**	**.065**
05HA (E67)	heart-warming	2.92	1.23	−0.08	−0.86	.816 [4]	−.215	−.195	−.266	−.302	−.094
06HA (E71)	my baby cute	3.67	1.10	−0.48	−0.34	.817 [3]	−.239	−.189	−.280	−.349	−.088
07HA (E59)	it was good	2.16	1.19	0.75	−0.38	.811 [5]	−.063	.027	−.076	−.141	.085
08HA (E28)	my baby dear to me	3.63	1.05	−0.40	−0.31	.761 [7]	−.259	−.205	−.309	−.388	−.117
09AN (E15)	irritated	2.05	1.02	0.47	−0.78	−.220	.808 [4]	.413	.546	.720 [6]	.276
10AN (E5)	**pissed me off**	**1.70**	**0.90**	**0.94**	**−0.24**	**−.163**	**.857 [1]**	**.414**	**.525**	**.691 [5]**	**.294**
11AN (E40)	got into rage	1.39	0.72	1.85	2.68	−.061	.824 [3]	.419	.545	.642 [3]	.316
12AN (E36)	mad	1.43	0.79	1.81	2.60	−.171	.856 [2]	.443	.591	.745 [7]	.330
13AN (E58)	wanted to shout	1.40	0.79	2.09	4.11	−.065	.802 [5]	.389	.476	.644 [4]	.292
14AN (E4)	**wanted to hurl something**	**1.31**	**0.65**	**2.04**	**3.30**	**−.139**	**.755 [6]**	**.405**	**.474**	**.591 [1]**	**.307**
15AN (E49)	hateful	1.22	0.58	3.01	9.87	−.117	.728 [7]	.494	.572	.638 [2]	.381
16FE (E6)	fear	1.45	0.82	1.83	2.75	−.109	.386	.757 [6]	.532 [2]	.405 [2]	.600 [3]
17FE (E60)	scared	1.28	0.65	2.51	6.30	−.095	.461	.758 [5]	.614 [6]	.489	.586 [2]
18FE (E31)	terror	1.42	0.79	1.97	3.42	−.058	.426	.785 [4]	.592 [5]	.462 [3]	.621 [5]

Continued

Item		M	SD	Skewness	Kurtosis							
19FE (E55)	frightened	1.19	0.54	3.42	13.09	−.049	.456	.609 [8]	.556 [3]	.462 [3]	.510 [1]	
20FE (E30)	**anxiety**	**2.17**	**1.12**	**0.52**	**−0.74**	**−.095**	**.423**	**.807 [2]**	**.634 [8]**	**.501 [5]**	**.619 [4]**	
21FE (E64)	nervous	1.58	0.90	1.33	0.72	.043	.313	.738 [7]	.489 [1]	.333 [1]	.693 [7]	
22FE (E68)	**frustrated**	**1.77**	**1.02**	**1.03**	**−0.02**	**−.116**	**.375**	**.824 [1]**	**.591 [4]**	**.470 [4]**	**.703 [8]**	
23FE (E43)	confused	1.82	1.08	1.05	0.07	−.151	.414	.804 [3]	.622 [7]	.510 [6]	.680 [6]	
24SA (E14)	sad	1.71	0.97	1.12	0.23	−.158	.492	.651 [5]	.814 [2]	.542 [3]	.539	
25SA (E35)	pessimistic	1.49	0.84	1.77	2.74	−.138	.549	.677 [6]	.847 [1]	.621 [5]	.500	
26SA (E34)	**lonesome**	**1.48**	**0.83**	**1.71**	**2.27**	**−.065**	**.493**	**.608 [4]**	**.807 [3]**	**.505 [2]**	**.514**	
27SA (E9)	**drearily**	**1.45**	**0.81**	**1.85**	**2.88**	**−.137**	**.450**	**.566 [3]**	**.774 [4]**	**.500 [1]**	**.466**	
28SA (E54)	disappointed	1.28	0.66	2.56	6.49	−.178	.514	.502 [1]	.683 [6]	.578 [4]	.413	
29SA (E10)	depressed	2.07	1.05	0.50	−0.71	−.325	.585	.532 [2]	.762 [5]	.721 [6]	.368	
30DI (E53)	**hated it**	**1.95**	**1.07**	**0.76**	**−0.40**	**−.281**		**.682 [5]**	**.534**	**.660**	**.859 [1]**	**.384**
31DI (E56)	wanted to throw it out	1.67	0.99	1.28	0.66	−.209		.674 [4]	.540	.644	.827 [5]	.380
32DI (E12)	fed up	1.86	0.96	0.72	−0.46	−.302		.685 [6]	.447	.598	.838 [4]	.286
33DI (E25)	annoyed	1.21	0.55	3.15	11.56	−.126		.538 [1]	.404	.512	.576 [8]	.333
34DI (E11)	made me sick	1.86	0.97	0.77	−0.38	−.293		.723 [8]	.465	.636	.850 [2]	.319
35DI (E50)	**troublesome**	**1.57**	**0.87**	**1.47**	**1.59**	**−.229**		**.660 [2]**	**.433**	**.569**	**.809 [6]**	**.317**
36DI (E32)	unpleasant	1.64	0.90	1.29	1.03	−.262		.673 [3]	.506	.592	.797 [7]	.390
37DI (E73)	dismal	1.53	0.84	1.54	1.81	−.214		.721 [7]	.470	.568	.843 [3]	.350
38SU (E46)	astonished	1.53	0.85	1.57	1.89	.034	.292	.637 [3]	.430	.315	.827	
39SU (E13)	**surprised**	**1.42**	**0.77**	**1.95**	**3.66**	**.018**	**.279**	**.535 [1]**	**.421**	**.302**	**.725**	

Continued

40SU (E51)	startled	**1.54**	**0.86**	**1.54**	**1.76**	**−.013**	**.293**	**.634 [2]**	**.453**	**.313**	**.829**
41SU (E44)	heart was pounding	1.77	0.99	1.09	0.40	.078	.284	.694 [4]	.475	.320	.826
42SU (E65)	upset	1.76	0.99	1.01	0.03	−.106	.376	.782 [5]	.588	.444	.802

Note. Selected items were in bold.

Table A2. Mean, SD, skewness, kurtosis item-total correlation for each item of the self-conscious emotions dimension of the SPBE (whole sample; *N* = 831) in Study 1.

						Item total correlation [rank]			
label (item No.)	Contents (abbreviated)	Mean	SD	skewness	kurtosis	Shame total	Guilt total	ALPHA factor	BETA factor
43SH (E27)	ashamed	1.17	0.50	3.39	12.91	.591 [10]	.447 [1]	−.042	−.049
44SH (E1)	pathetic	1.52	0.81	1.60	2.29	.682 [7]	.552 [5]	−.108	−.102
45SH (E21)	**felt like hiding away**	**1.40**	**0.76**	**1.92**	**3.12**	**.648 [9]**	**.478 [2]**	**−.109**	**−.152**
46SH (E26)	miserable	1.26	0.65	3.02	10.08	.668 [8]	.524 [3]	−.070	−.067
47SH (E33)	felt bad	1.92	1.02	0.74	−0.36	.715 [6]	.788 [10]	−.112	−.103
48SH (E47)	**felt like escaping**	**1.68**	**0.98**	**1.20**	**0.50**	**.725 [5]**	**.519 [4]**	**−.180**	**−.232**
49SH (E8)	lack of confidence	2.03	1.08	0.69	−0.48	.790 [3]	.653 [6]	−.188	−.191
50SH (E24)	powerless	1.80	1.02	1.12	0.42	.816 [2]	.675 [8]	−.211	−.226
51SH (E63)	I was horrible	1.48	0.83	1.75	2.57	.768 [4]	.726 [9]	−.092	−.108
52SH (E52)	disqualified as a mother	1.52	0.85	1.74	2.81	.827 [1]	.678 [7]	−.121	−.104
53GU (E7)	guilty	1.93	1.06	0.70	−0.58	.603 [2]	.781 [4]	−.168	−.156
54GU (E23)	**there was no excuse**	**2.04**	**1.07**	**0.53**	**−0.78**	**.646 [6]**	**.822 [1]**	**−.162**	**−.176**
55GU (E22)	inferior	1.42	0.76	1.79	2.50	.674 [7]	.714 [7]	−.097	−.114
56GU (E61)	sorry	2.22	1.11	0.32	−0.92	.465 [1]	.660 [8]	−.116	−.127

Continued

57GU (E69)	regretted	1.25	0.58	2.66	8.00	.610 [3]	.596 [9]	−.065	−.097
58GU (E48)	**I did something wrong**	**1.54**	**0.86**	**1.45**	**1.24**	**.638 [5]**	**.786 [3]**	**−.078**	**−.071**
59GU (E38)	I did something horrible	1.48	0.79	1.73	2.81	.621 [4]	.718 [6]	−.048	−.038
60GU (E16)	this was my responsibility	1.89	1.02	0.86	−0.06	.729 [9]	.798 [2]	−.139	−.121
61GU (E19)	I was accused	1.64	0.93	1.33	0.10	.676 [8]	.745 [5]	−.139	−.166
62ALPHA (E66)	satisfied as a mother	1.97	1.02	0.84	0.04	−.126	−.125	.856 [2]	.764 [5]
63ALPHA (E70)	proud of me as a mother	2.04	1.08	0.83	−0.05	−.145	−.140	.892 [1]	.795 [6]
64ALPHA (E18)	proud being needed	2.59	1.15	0.26	−0.62	−.195	−.155	.779 [6]	.722 [4]
65ALPHA (E29)	**I was a good mother**	**2.05**	**0.98**	**0.92**	**0.66**	**−.167**	**−.157**	**.830 [4]**	**.693 [2]**
66ALPHA (E20)	**competent as a mother**	**1.82**	**0.95**	**1.23**	**1.34**	**−.152**	**−.138**	**.813 [5]**	**.678 [1]**
67ALPHA (E45)	wonderful caring a crying baby	2.05	1.04	0.85	0.23	−.114	−.081	.835 [3]	.709 [3]
68BETA (E41)	**content with baby care**	**2.44**	**1.13**	**0.47**	**−0.42**	**−.193**	**−.180**	**.781 [5]**	**.900 [1]**
69BETA (E17)	satisfied with my baby cry	1.84	0.98	1.12	0.81	−.099	−.098	.554 [1]	.677 [6]
70BETA (E57)	**fulfilled in baby care**	**2.43**	**1.13**	**0.42**	**−0.51**	**−.164**	**−.132**	**.751 [3]**	**.876 [2]**
71BETA (E37)	proud of my baby care	2.30	1.10	0.64	−0.23	−.123	−.109	.803 [6]	.870 [3]
72BETA (E42)	did a good baby care	2.14	0.98	0.72	0.27	−.178	−.145	.794 [4]	.843 [4]
73BETA (E3)	wonderful to look after a crying baby	2.82	1.04	0.17	−0.47	−.114	−.081	.595 [2]	.730 [5]

Note. Selected items are in bold.

Table A3. Study 1; Coefficients omega subscale and alpha coeficients subscale of the SPBE-20 (whole sample $N = 831$).

	6-Basic emotions model					
	Happiness	Anger	Fear	Sadness	Disgust	Surprise
Coefficient omega subscale	.810	.773	.789	.740	.772	.668
Alpha coefficient	.798	.745	.787	.740	.759	.661

Continued

4-Self-conscious emotions model				
	Shame	Guilt	Alpha	Beta
Coefficient omega subscale	.743	.742	.805	.881
Alpha coefficient	.722	.730	.805	.878

Table A4. Study 1; Measurement invariances of the 6-Basic emotion model of the SPBE-20.

	χ^2	df	χ^2/df	$\Delta\chi^2$ (df)	CFI	ΔCFI	RMSEA	ΔRMSEA	Judgfment
nulliparae (*n* = 426) vs. miltiparae (*n* = 404)									
Configural	134.435	78	1.724	Ref	.985	Ref	.030	Ref	ACCEPT
Metric	143.930	84	1.713	9.496 (6)***	.984	.001	.029	+.001	ACCEPT
Scalar	299.918	96	3.124	155.988 (12)***	.944	.040	.051	.022	REJECT
younger age group (age ≤ 33 years old: *n* = 431) vs. elder age group (age ≥ 34; *n* = 397)									
Configural	159.415	80	1.993	Ref	.980	Ref	.035	Ref	ACCEPT
Metric	164.136	86	1.909	4.721 (6)*NS*	.980	.000	.033	+.002	ACCEPT
Scalar	176.340	98	1.799	12.203 (12) *NS*	.980	.000	.031	+.002	ACCEPT
Residual	187.451	109	1.720	11.112 (11) *NS*	.980	.000	.030	+.001	ACCEPT
Factor variance	194.916	115	1.695	7.465 (6) *NS*	.980	.000	.029	+.001	ACCEPT
Factor covariance	223.074	130	1.716	28.158 (15)*	.976	.004	.029	.000	ACCEPT

*p < .05; ***p < .001; *NS*, not significant.

Table A5. Study 1; Measurement invariances of the 4-Self-conscious emotions model of the SPBE-20.

	χ^2	df	χ^2/df	$\Delta\chi^2$ (df)	CFI	ΔCFI	RMSEA	ΔRMSEA	Judgfment
nulliparae (*n* = 426) vs. miltiparae (*n* = 404)									
Configural	49.667	28	1.774	Ref	.992	Ref	.031	Ref	ACCEPT
Metric	54.899	32	1.716	5.232(4)***	.991	.001	.029	+.002	ACCEPT
Scalar	109.476	40	2.737	54.576 (8)***	.974	.017	.046	.017	REJECT
younger age group (age ≤ 33: *n* = 431) vs. elder age group (age ≥ 34; *n* = 397)									
Configural	48.597	28	1.736	Ref	.993	Ref	.030	Ref	ACCEPT
Metric	55.338	32	1.729	6.741 (4)*NS*	.992	.001	.030	.000	ACCEPT
Scalar	71.194	40	1.780	15.856 (8)*	.989	.003	.031	.001	ACCEPT
Residual	109.278	48	2.277	38.083 (8)***	.978	.011	.039	.008	ACCEPT
Factor variance	116.757	52	2.245	7.480 (4)*NS*	.976	.002	.039	.000	ACCEPT
Factor covariance	125.363	58	2.161	8.606 (6)*NS*	.976	.000	.027	+.004	ACCEPT

*p < .05;***p < .001; *NS*, not significant.

Table A6. Study 1; Factor mean (SE) of younger age group (age ≤ 33: *n* = 431) compared with elder age group (age ≥ 34; *n* = 397) for the SPBE-20.

	6-Basic emotions model					
	Happiness	Anger	Fear	Sadness	Disgust	Surprise
Factor mean (SE) of younger age group (age ≤ 33: *n* = 431) compared with elder age group (age ≥ 34; *n* = 397)	−0.032 (.093)*NS*	0.077 (0.038)*	0.051 (0.064)*NS*	0.093 (0.048)*NS*	0.046 (0.051)*NS*	0.141 (0.056)*

	4-Self-Conscious emotions model			
	Shame	Guilt	Alpha	Beta
Factor mean (SE) of younger age group (age ≤ 33: *n* = 431) compared with elder age group (age ≥ 34; *n* = 397)	0.126 (0.065)*NS*	0.000 (0.054)*NS*	0.045 (0.059)*NS*	−0.058 (0.069)*NS*

*p < .05;***p < .001; *NS*, not significant.

Table A7. Study 2 (*N* = 696); Mean, SD, skewness, kurtosis, communalities for the Basic emotions scale of the SPBE-20.

Variable Name (Full-version's label)	Contents (abbreviated)	Mean	SD	skewness	kurtosis	communality
SP11 (03HA)	enjoy	4.6	1.34	−1.15	1.56	.30
SP20 (04HA)	glad	5.5	0.86	−2.31	7.75	.43
SP8 (10AN)	pissed me off	0.20	0.72	4.43	21.87	.41
SP1 (14AN)	wanted to hurl something	0.44	1.10	2.68	6.65	.43
SP9 (20FE)	anxiety	3.5	1.71	−0.75	−0.17	.25
SP19 (22FE)	frustrated	1.29	1.67	0.89	−0.66	.39
SP10 (26SA)	lonesome	0.40	1.04	2.79	6.96	.43
SP2 (27SA)	drearily	0.95	1.54	1.45	0.84	.46
SP17 (30DI)	hated it	0.52	1.17	2.25	4.03	.45
SP15 (35DI)	troublesome	1.00	1.62	1.45	0.86	.47
SP3 (39SU)	surprised	2.28	1.98	0.13	−1.37	.19
SP16 (40SU)	startled	1.58	1.84	0.60	−1.18	.32

Table A8. Study 2 (*N* = 696); Mean, SD, skewness, kurtosis, communalities for the Self-conscious emotions scale of the SPBE-20.

Variable Name (Full-version's label)	Contents (abbreviated)	Mean	SD	skewness	kurtosis	communality
SP5 (45SH)	felt like hiding away	0.45	1.04	2.41	4.96	0.28
SP13 (48SH)	felt like escaping	1.28	1.72	1.03	−0.25	0.37
SP6 (54GU)	there was no excuse	0.93	1.55	1.51	1.04	0.40
SP14 (58GU)	I did something wrong	0.45	1.10	2.74	7.13	0.39
SP7 (65ALPHA)	I was a good mother	2.07	1.44	−0.05	−0.74	0.48
SP4 (66ALPHA)	competent as a mother	2.36	1.35	−.39	−0.34	0.54
SP12 (68BETA)	content with baby care	4.66	1.38	−1.09	1.09	0.60
SP18 (70BETA)	fulfilled in baby care in baby care	4.33	1.47	−0.79	0.44	0.60

Table A9. Study 2 (*N* = 696); model comparison for the Basic emotions scale of the SPBE-20.

model (*n* = 696)	χ^2/df	$\Delta\chi^2$ (*df*)	CFI	ΔCFI	RMSEA	ΔRMSEA	AIC
		A Model derived from EFA					
1-factor	610.857/54 = 11.32	Ref	.785	Ref	.122	Ref	682.857
2-factor	424.698/51 = 8.327	186.159(3) ***	.856	.071	.103	.019	502.698
3-factor	282.431/47 = 6.009	142.267(4) ***	.909	.053	.085	.018	368.431
		The theoretical model					
6-Basic emotions model	165.773/39 = 4.251	445.084(15) ***	.951	.166	.068	.054	267.773

Note. CFI, comparative fit index; RMSEA, root mean square error of approximation; AIC, Akaike information criteria. ***p < .001.

Table A10. Study 2 (*N* = 696); model comparison for the Self-conscious emotions scale of the SPBE-20.

model (*n* = 696)	χ^2/df	$\Delta\chi^2$ (*df*)	CFI	ΔCFI	RMSEA	ΔRMSEA	AIC
		Models derived from EFA					
1-factor	1199.223/22 = 54.510	Ref	.418	Ref	.277	Ref	1243.223
2-factor	696.571/21 = 33.170	502.652(1)***	.666	.248	.215	.062	742.571
3-factor	135.927/19 = 7.154	560.644 (2)***	.942	.276	.094	.121	185.927
		The theoretical model					
4-Self-conscious emotions model	88.122/16 = 5.508	47.805(5)***	.964	.022	.081	.013	144.122

Note. CFI, comparative fit index; RMSEA, root mean square error of approximation; AIC, Akaike information criteria. ***p < .001.

Table A11. Study 2; Coefficient omega subscales and alpha coefficients speciphic factors of the SPBE-20 (whole sample $N = 696$).

6-Basic emotions model						
	Happiness	Anger	Fear	Sadness	Disgust	Surprise
Coefficient omega subscales	.697	.649	.591	.715	.741	.593
Alpha coefficients	.798	.745	.787	.740	.759	.661
4-Self-conscious emotions model						
	Shame		Guilt		Alpha	Beta
Coefficient omega subscales	.613		.719		.848	.862
Alpha coefficients	.722		.730		.805	.878

Table A12. Study 2; Measurement invariances of the 4-Self-conscious emotions model of the SPBE-20.

	χ^2	df	χ^2/df	$\Delta\chi^2$ (df)	CFI	ΔCFI	RMSEA	ΔRMSEA	Judgment
nulliparae ($n = 512$) vs. miltiparae ($n = 184$)									
Configural	121.997	32	3.812	Ref	.956	Ref	.064	Ref	ACCEPT
Metric	128.692	36	3.575	6.695(4)NS	.955	.001	.061	+.003	ACCEPT
Scalar	148.739	44	3.380	20.047(8)*	.949	.002	.059	+.002	ACCEPT
Residual	167.227	50	3.345	18.488(6)**	.943	006	.058	+.001	ACCEPT
Factor variance	170.668	54	3.161	3.441(4)NS	.943	.000	.056	+.002	ACCEPT
Factor covariance	175.446	60	2.924	4.778(6)NS	.944	.001	.053	+.005	ACCEPT
younger age group (age ≤ 31: $n = 344$) vs. elder age group (age ≥ 32; $n = 352$)									
Configural	111.620	32	3.488	Ref	.961	Ref	.060	Ref	ACCEPT
Metric	112.883	36	3.136	1.263(4)NS	.962	+.001	.055	+.005	ACCEPT
Scalar	125.958	44	2.863	13.074(8) NS	.960	+002	.052	+.003	ACCEPT
Residual	149.813	50	2.994	23.855(6)**	.951	.009	.054	+.002	ACCEPT
Factor variance	160.857	54	2.979	11.044(4)*	.947	.004	.053	+.001	ACCEPT
Factor covariance	171.416	60	2.857	10.560(6) NS	.945	.002	.052	+.001	ACCEPT

$^*p < .05$; $^{**}p < .01$; $^{***}p < .001$; NS, not significant.

Table A13. Study 2; Factor mean (SE) of the 4-Self-conscious emotions model of the SPBE-20.

4-Self-Conscious emotions model				
	Shame	Guilt	Alpha	Beta
Factor mean (SE) of Nulliparae ($n = 512$) compaired with multiparae ($n = 184$)	0.329 (0.139)*	0.095 (0.253) NS	−0.123 (0.106) NS	−0.008 (0.120) NS
Factor mean (SE) of the younger age group (age ≤ 31: $n = 344$) compaired with the elder age group (age ≥ 32; $n = 352$)	0.255 (0.120) *	0.085 (0.075) NS	−0.011 (0.093) NS	−0.073 (0.105) NS

$^*p < .05$; $^{***}p < .001$; NS, not significant.