**An Exploratory and Confirmatory Secondary Factor Analysis: The Significance of Demographic Variables in Measuring Household Chaos and Bedtime Routines**

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**Abstract**

***Background****:* Implementing optimal bedtime routines is crucial for healthy child development and wellbeing. Household chaos has been shown to adversely affect bedtime routines. Evaluating and modifying existing assessment instruments is essential for understanding theory and targeting vulnerable family brackets.

***Aims:*** This study aims to evaluate the six-item CHAOS and Bedtime Routine questionnaire items and their contributions to the latent constructs ‘Household Chaos’ and ‘Bedtime Organization’ using EFA and CFA techniques. Additionally, it assesses the contribution of demographic variables to the measurement of latent constructs.

***Participants:*** Secondary data from 225 parents of children aged 2-6 years were used for secondary analysis.

***Results:*** EFA revealed a 12-item, three-factor model named ‘Household Chaos’, ‘Bedtime Organization’, and ‘Screen Absence’. The model had a GFI of 0.91 with an RMSR of 0.05. ‘Good’ internal reliability was identified for the Household Chaos scale (α=0.71), and ‘acceptable’ internal reliability for the Bedtime Routine questionnaire (α=0.56). The EFA model explained 62% of the variance in the data. The CFA yielded a two-factor model with 8 items, providing exceptional fit to the data (χ² (df=19) = 0.99, CFI=1.00, RMSEA=0.00, SRMR=0.063).

***Conclusion:*** The analysis does not support the use of two items on the CHAOS questionnaire regarding screen use in measuring Household Chaos. Factor analysis indicates the need for novel items to enhance the reliability of the Bedtime Routine questionnaire. No demographic variables were found to be meaningful for inclusion in either questionnaire.

*Keywords: Factor Analysis, Household Chaos, Bedtime Routines, Child Development*

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**An Exploratory & Confirmatory Secondary Factor Analysis: Are Demographic variables significant in the measurement of Household Chaos and Bedtime Routines?**

The Introduction Chapter below summarises current knowledge in the field of household chaos and bedtime routines and tools applied in measuring these constructs. Theories relevant to the research areas are addressed in this study. Research studies involving this field are sparse, whereby older studies have focused on basic theories, and more current studies attempt to tailor measurement of constructs to their theoretical backgrounds. This chapter explores a) The importance and rationale of the research focus at hand, b) The usage and tools in measuring latent constructs in psychological research and c) the study objectives and research questions.

# **Chapter I**

## **1.1 Significance of Bedtime Routines:**

*"Practice does not make perfect. It is practice, followed by a night of sleep, that leads to perfection." - Matthew Walker, Why We Sleep: The New Science of Sleep and Dreams.*

Bedtime Routines (BR) are critical for the optimum development of young children and allow for positive developmental outcomes involving literacy and health (Hale, LeBourgeois, and Brooks 2011, Mindell, Sadeh, Kwon, and Goh, 2015). These influence constructive parent-child attachment, dental hygiene, sleep hygiene and emotional wellbeing, and involve the routines that occur prior to the child falling asleep (Scher and Asher 2004, Davies and Bridgeman 2011, Mindell et al. 2015). There is no ‘gold standard’ for what constitutes an optimal BR, however certain components of a more structured and beneficial bedtime routine have been previously suggested by Mindell and Williamson (2018). These criteria include hygiene (bathing and brushing teeth), physical contact (cuddling and massage), nutrition (bottle feeding, healthy snack) and modes of communication (bedtime stories and singing). These criteria are manifested cross-culturally, however with varying degrees of perceived importance (LeBourgeois et al. 2005).

The pivotal role of sound BR structure can be assessed by examining the detrimental impacts of irregular bedtime routines on children’s sleep, emotional and developmental processes. Inconsistent and disorganized bedtime routines have been demonstrated to impact the cognitive functioning, mood and emotional regulation of children (Turnbull, Reid and Morton 2013, Williams, Berthelsen, Walker and Nicholson, 2017). This occurs because of BR being strongly linked to sleep hygiene, whereby disruptions or absences in a regular BR can result in a reduction in sleep duration, an increase in nighttime awakenings and an increased sleep onset latency (Fiese, Winter, and Slewinski, 2007, Mindell and Williamson, 2018).

Effective sleep during development is crucial to cognitive functioning ineffective sleep-in children has been linked to difficulties with attentional processes, impulse control, and behavior regulation (Paavonen et al. 2009). Neural correlates of these dysfunctions have been proposed, whereby Kohyama (2016) suggests that with reduced sleep quality and duration, there is a significant impairment in the serotonergic system which encompasses the ventral and dorsal striatum, and a reduced prefrontal cortex functioning leading to the described cognitive and socioemotional deficits. Mindell et. al. (2018) created a hypothetical model containing constructs that are influential in bedtime routine organization. It involves a flow chart highlighting the components and hypothesized positive outcomes of consistent BR. Figure 1 below depicts this model.

Figure 1

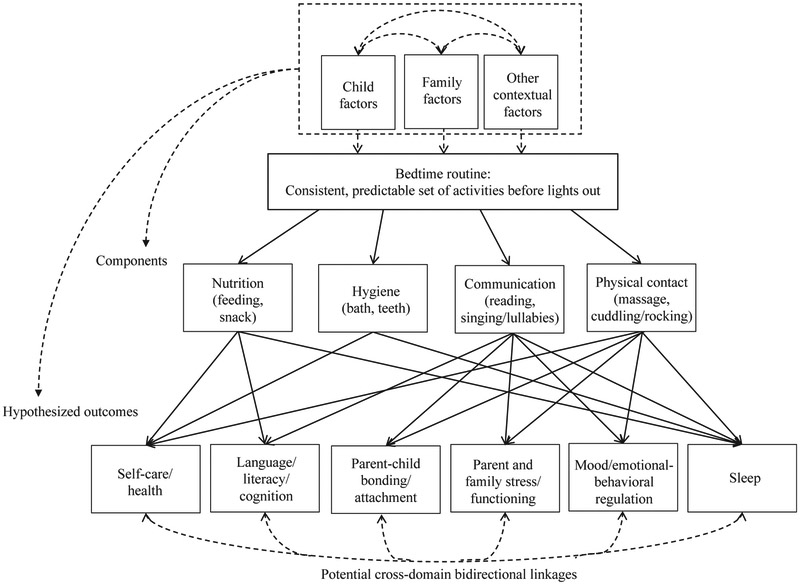
[](https://www.ncbi.nlm.nih.gov/core/lw/2.0/html/tileshop_pmc/tileshop_pmc_inline.html?title=Click%20on%20image%20to%20zoom&p=PMC3&id=6587181_nihms-1036167-f0001.jpg)

Figure 1 Mindell and Williamson’s (2018) hypothesized model of constructs and benefits of bedtime routines.

According to Mindell and Williamson’s (2018) model, the latent construct ‘Bedtime Routine’ is composed of the measurable items; nutrition, hygiene, communication and physical contact. Additionally, child factors, family factors and other contextual factors could influence the efficacy of the construct ‘bedtime routines’ in a positive or negative manner, and this in turn could have a knock-on effect on the ‘hypothesized outcomes’; elevated self-care, mood, sleep and parent-child bonding.

A diagram demonstrating how negative factors could potentially influence bedtime routines was devised according to Mindell and Williamsons (2018) hypothesized impact of BR (Figure 2). However, in this diagram it has been modified to incorporate negative contextual and demographic factors, and their potential impact on BR.

**A screenshot of a cell phone

Description automatically generated**Figure 2

Figure 2:Modification of Mindell and Williams (2018) model of hypothesised constructs. Constructs include Household chaos, Low household income, Low maternal education and No. of Children in the household, which potentially reduce bedtime activities and hypothesised positive outcomes.

To be able to study relationships such as those highlighted in Figure 2, further exploratory factor analyses of the variables underlying construct ‘Bedtime Routines’ is paramount. Since the BR questionnaire is relatively new (Fuller, 2017), and has not been used extensively, more in-depth studies investigating factor loadings and variance explained by the items would help elucidate interpretation on this construct.

An alternative motive for research on BR’s is economical, whereby Hafner, Stepanek, Taylor, Troxel and van Stolk (2017) highlight that sleep can result in significant economic costs as a result of lack of productivity, and potentially dysfunctions in language development, mood disorders and cognitive disorders. Therefore, BR’s should be targeted when researching aspects of child development and providing an accurate and universal measure of BR’s is essential.

## **1.2 Household Chaos and its Negative impacts**

*“The strength of a nation derives from the integrity of the home” – Confucius.*

Household chaos, defined as an environment lacking structure, stability, and characterized by noise, crowding, family instability, lack of routine, and persistent television use (Fiese and Winter, 2010; Martin, Razza, & Brooks-Gun, 2012), has significant implications for familial and individual well-being. The CHAOS scale (Confusion, Hubbub, and Order scale) developed by Matheny (1995) is commonly used to measure household chaos, with a shortened six-item version demonstrating acceptable reliability (Cronbach's α = 0.67, Wong et al., 2007), aiming to improve participant engagement and response rates (Sahlqvist et al., 2011).

While some debate exists regarding whether household chaos is a standalone construct or a proxy for other adverse social factors (Dumas, 2005), research has established clear associations between chaos, parenting difficulties, and socioeconomic status (Coldwell, Pike, & Dunn, 2006; Mills-Koonce et al., 2015). Chaos within the home is linked to parental depression, child behavioural issues (Dumas et al., 2005; Huer, Buettner, & Jeon, 2015), and even early academic achievement (Garret-Peters et al., 2017), impeding cognitive development (Berry et al., 2016). Furthermore, chaos disrupts sleep hygiene, potentially mediating cognitive competency (Whitesell et al., 2018), though its impact on bedtime routines remains underexplored.

Beyond sociological and family well-being, household chaos affects physiological health, with children in chaotic environments exhibiting elevated blood cortisol levels due to stress (Brown et al., 2019). Prolonged stress during childhood can result in neurological deficits, affecting neural architecture and increasing susceptibility to mental health conditions like anxiety (Weaver et al., 2004; Coley, Lynch, & Kull, 2016).

Understanding the components of household chaos and mitigating its negative impacts are crucial for preventing future mental and cognitive deficits, alleviating economic burdens associated with mental health problems (The Mental Health Taskforce, 2016), and safeguarding children's cognitive and socioemotional well-being. Targeted interventions aimed at reducing household chaos are essential for promoting healthier family environments and preventing long-term consequences.

## **1.3 Exploratory and Confirmatory Factor analysis techniques in psychological research:**

*Exploratory Factor Analysis (EFA):* Spearman (1904) first established the concept of EFA, and since then it has been widely used in various areas of psychological research, including questionnaire development and modification. Questionnaires which have been developed or adjusted using EFA include the General Health Questionnaire-12 (ODriscol, Brough and Kalliath 2004), the Coping Strategies questionnaire (Riley and Robinson, 1997) and the GAD (Generalised Anxiety Disorder) self-report scale (Mordeno et al. 2019).

EFA is a data reduction technique which aims to reduce a set of variables into corresponding ‘Factors’; reducing a group of observed variables that correspond into corresponding latent constructs (Gorsuch, 1983). Factors and Latent constructs are used interchangeably in this paper. It demonstrates the strengths of relationships between these variables and is commonly used in psychological research due to the presence of latent constructs, such as ‘personality’, or ‘anxiety’ being customary (Fabrigar et al. 1999). EFA assumes that any variables entered the analysis could be related, and thus makes no priori assumptions about the relationships between variables. It is primarily used in questionnaire development and allows for the discovery of ‘relationships between the individual item variances and common variances shared between items’ (Samuels, 2017). Factor analysis differs to Principal Components Analysis by virtue of allowing for communality measurements, which involves the ratio of an item’s unique variance to its shared variance (Santos et al., 2019). While EFA suggests a model that explains the latent constructs and the data, Confirmatory Factor Analysis is required to validate the model and fit to the data.

*Confirmatory Factor Analysis (CFA):* This is a technique used to verify factor structure according to a theoretical or exploratory factor analysis model. It allows for confirming the hypothesis that underlying latent constructs exist and may differ to the suggested EFA model. Examples of psychometric testing that used CFA to validate their scales included ‘The Neglect scale’ developed by Straus, Kinard and Williams (1995). The identified factor structure was validated using CFA by Harrington (2002). Other scales include the Professional Opinion Scale (Abbott, 2003), the Wechsler Memory Scale (Burton et al. 2003) and the Enriched Life Scale (Angel et al. 2019). One way of conducting the analysis involves use of Structural Equational Modelling (SEM). While CFA allows for confirmation of factors, SEM establishes relationships among common factors and a more detailed analysis of an exploratory factor analysis model (Stein, Morris, Nock, 2012).

## **1.4 Tools in conducting EFA and CFA:**

Development and assessment of psychometrically sound scales are informed by guidelines including the American Psychological Association (APA) and SAGE publications on psychometric scale development (Furr, 2011). They posit that a scale should be assessed for: a) Dimensionality (i.e. Factor Structure), b) Internal Consistency, c) Construct Validity and d) Advanced Psychometric testing (e.g. Confirmatory Factor Analysis).

Several types of statistical software can be applied when carrying out factor analysis:

1. SPSS (all versions) – Exploratory Factor Analysis
2. AMOS – Structural Equational modelling
3. RStudio – Exploratory and Confirmatory Factor Analysis
4. Lisrel
5. MPlus

There are strengths and limitations with each software, and in order to maximise the potential for an integrative and in-depth factor analysis, a combination of these software will be implemented in this study; SPSS (Version 25), RStudio (Version 1.25033), and AMOS (Version 26). SPSS was used for descriptive statistics, for the Exploratory Factor Analysis, RStudio, for corroborating the Exploratory Factor analysis, and AMOS for the Confirmatory Factor Analysis. This method provides additional information regarding usage of various software in carrying out the analysis and could provide suggestions to future psychology students in tools that are useful in carrying out EFA and CFA given similar circumstances.

## **1.5 Study Objectives:**

The purpose of this secondary analysis was to conduct an exploratory and confirmatory factor analysis to evaluate factorability of items on the CHAOS (Matheny, 1995) and Bedtime Routine Scales (Fuller, 2017). This would indicate importance of items to their subsequent latent constructs and allow for a wider theoretical understanding of the importance of items in explaining any variance present within both questionnaires. Additionally, demographic factors were analysed for potential explanation of variance not accounted for within the questionnaires.

This analysis further highlights items which associate the latent constructs ‘Household Chaos’ and ‘Bedtime Organisation’ together and warrant further exploration of theory. This would add to the extant literature on household chaos and its impacts on routines within the household. Three Research Questions (RQ) are listed below:

**RQ1:** ‘What EFA model best fits the data according to items on the CHAOS and Bedtime Routine questionnaires?’

**RQ2 ‘**What are the dimensions of the final EFA model underlying the CHAOS and Bedtime Routine questionnaires? Do any demographic variables load onto any factor?’

**RQ3**: ‘Can Confirmatory Factor Analysis validate the EFA model? What final CFA model is best fitting to the data?

Hypotheses relating to these research questions are as follows:

**H1:** A two factor model arises from the EFA, and items on both questionnaires will load onto their theoretical latent constructs - Household Chaos and Bedtime Organisation.

**H2:** All questionnaire items have a factor loading above 0.4. Demographic characteristics will play a role in factoring onto the latent constructs; however, the strengths of these associations are low (<0.4).

**H3:** The CFA validates the proposed two factor EFA model.

Null hypotheses for these research questions are shown below:

**NH1:** A simple structure does not emerge demonstrating two factors.

**NH2:** Demographic characteristics do not play a role in factoring onto the latent constructs.

**NH3:** CFA does not validate the EFA model.

# Chapter II

## **Method**

This secondary analysis aims to assess the existing Confusion, Hubbub and Order Scale (CHAOS, Matheny et al. 1995) and the Bedtime Routine scale (BR, Fuller 2017) using EFA and CFA for importance of questionnaire items in factoring onto their latent constructs. Additionally, the study aims to address whether demographic factors may pose useful in explaining some of the variance that may be unaccounted for within the questionnaires. This could provide a wider theoretical basis for assessment of both chaos within the household and bedtime organization and may lay the posit future theoretical concepts for research in this area.

### **2.1 Participants:**

Participants included in this study were 216 Mothers and 9 Fathers who were primarily white-Caucasian and British ethnicity. With Likert-type data, the median is considered a more accurate measure of central tendency than the mean (Douven, 2018). The median level of Mother Education was *Mdn =* 3.00 *(SD =*1.13*),* equivalent to an undergraduate degree and Income *Mdn* = 5.00 *(SD=*1.95*),* equivalent to an annual household income of £55-65,000. Most of the children were male *(Mdn =* 0.00*, SD =* 0.499*)* and most families had two children (*Mdn =* 2.00*, SD =* 0.681*).*

Education level averaged as being high, with most parents having had some level of university level education or above. Responses ranged from (‘*GCSE/Some high school education’* to ‘*PhD or Equivalent*’). Recruitment of participants originally involved social media and advertisements conducted by the University of Sussex’s WORD lab. Participants could additionally email WORD lab researchers. They were offered to take part in a £25 prize draw for completing the questionnaires and demographic questions via the Qualtrics platform. For this study, an excel file with raw data was provided, with the responses to the questionnaires, and the data set was analyzed in this study. All data was collected and included in the study by Fuller (2017).

As this study will be applying Exploratory and Confirmatory analysis techniques, calculations determining an adequate sample size could not be determined using G\*Power. There is no gold standard method for calculating adequate sample size for EFA and CFA techniques, and researchers vary greatly in providing ‘rule of thumb’ guidance (Williams, Onsman and Brown, 2011). Therefore, it is optimal to follow several suggestions:

Sampling adequacy was assessed using Bartlett’s tests, Kaiser-Mayer Olkin tests, following sampling size recommendations and confirmation of more than two loaded variables onto each factor after conduction of the EFA (Bartlett 1951, Kaiser 1970, Field, Milo and Field 2012, Comrey and Lee 1992). It was concluded that the number of participants available in the data set (*N*=225) was appropriate for EFA and CFA as the named criteria for sampling adequacy were all met (Bartlett’s *X*² (120) = 693, *p <* 0.001, *KMO* = 0.74, HC scale *a* = 0.71, BR scale *a* = 0.60).

### **2.2 Items and Materials:**

Questionnaires which were provided by original researchers included the CHAOS scale (Matheny et al. 1995), a novel bedtime routine scale, a Wellbeing scale, WHO-5 (WHO, 1998) and a mealtime routine scale. The mealtime and WHO-5 scale will not be included in this secondary analysis as they are not relevant to the current study.

*Household chaos:* The CHAOS scale (Matheny et al., 1995) was a shorter form of the original 15 item scale, consisting of 6 items that were scored on a 5-point Likert scale (1= ***Strongly disagree***, 5 = ***Strongly agree***). They included items including “*It’s a real zoo in our home*”, and “*We limit screen time*”. An overall chaos score was calculated, indicative of more chaos within the household.

*Bedtime routines:* The original experiment involved a novel bedtime routine questionnaire, consisting of 7 items on a 5-point Likert scale (1=***Strongly disagree***, 5=***Strongly agree***). Examples of items included “*the children are regularly read stories at bedtime*,” and “*The children have a regular bedtime routine (e.g., same bed each night, a bath before bed, reading a story)*.”

### **2.3 Demographic information:**

*Number of Children in the Household*: Parents were asked how many siblings their youngest child has. Responses ranged from 0 – 3. Based on these values, a novel variable ‘No. of Children in the household’ was devised. Values ranged from 1-4.

*Income and Maternal education:* Parents were questioned on their education level and household income. Previous research links maternal education level and income to socioeconomic status (Field, Milo and Filed, 2012), therefore these variables were used as socioeconomic status indicators.

*Age:* Parents were asked for the age of their child which they used to respond to the questionnaires. The child’s age ranged from 2-6 years old.

*Sex:* The child’s sex was recorded. The data was quantified so that boys were given dummy variable of 0 and girls 1. (*M =* 0.46*).*

### **2.4 Data Analysis:**

EFA and descriptive statistical analyses were conducted on RStudio (Version 1.2.5033), while CFA analyses were done using Structural Equational Modelling (SEM, Wright 1918) in Amos (IBM, SPSS 26 Graphics). The data file was screened to ensure there were no missing entries for the relevant variables. Descriptive statistics were conducted first. Research questions studies are shown below with their relevant methods for assessment:

*Is the sample size adequate for conduction of EFA and CFA?’:*

This was assessed using the previously named sampling adequacy tests. Values of Cronbach’s alpha above 0.5 were considered satisfactory for conducting the EFA (Field, Milo and Field, 2012). Bartlett’s sphericity was considered significant at *p* < 0.05 (Bartlett,1951) and KMO values required minimum of 0.5 for conduction of EFA (Field, Milo and Filed, 2012). Additionally, spearman’s correlations coefficients were calculated, and any variables which did not correlate strongly were excluded. Twelve items were considered suitable to run the analysis: hc1, hc2, hc3, hc4, hc5, hc6, br1, br2, br3, br4, br6 and Mother Education.

*RQ1: What EFA model best the data?*

Parallel analysis (Horn, 1965) was conducted according to Maximum Likelihood method (ML) with oblimin rotation after developing a Spearman’s correlation matrix. Maximum Likelihood method of extraction was preferred over Principal Axis Factoring (PAF) due to providing greater goodness of fit indexes and permits statistical significance testing of factor loadings (Osbourne et al. 2008).

When assumptions of normality are violated, it is recommended to use PAF (Kasper and Uenlu, 2013). However, using a robust, non-parametric spearman’s correlation can prove to be robust enough to overcome violations of non-normality, and the use of Maximum Likelihood in this case is permitted (Ghasemi and Zahedias, 2012).

Oblique rotation was used as it allows for factors to be correlated if need be (SAGE, Allen 2017). The final EFA model included a 3-factor model with 9 items. The cutoff point of communalities was placed lower than usual, at +-0.3 due to assessing factoring relationships, and not for questionnaire development. Typically, a factor loading cut-off point is placed at 0.4 for questionnaire construction but can be placed lower when assessing constructs present (Guadagnoli and Velicer, 1988).

*RQ2: What are the dimensions of the final EFA model underlying the CHAOS and BR questionnaires:*

Demographic information investigated included household income, age, sex, mother education and number of children in the household. This question was assessed by assessing demographic characteristics loaded onto any factors, and the strengths of these loadings.

*RQ3: Can Confirmatory Analysis validate the EFA model? What final CFA model is best fitting to the data?’:*

Confirmatory factor analysis was conducted according to maximum likelihood and oblimin rotation. A CFA model according to the final model produced in the EFA was developed. This model was considered unsuitable, and a 2-factor model with 12 variables proved to be the best fitting model for the data according to CFA.

### **2.5 Ethical considerations:**

The proposed secondary analysis was submitted to the Sussex Ethics committee and was approved under code: ER/NM401/1. Participants in the original study were provided with a consent form and were informed of data confidentiality and that their responses would be anonymous. This was maintained for this secondary data analysis.

An Excel file was provided by the original researcher with data gathered from the original study, including relevant demographic information and answers to the four questionnaires (CHAOS, Bedtime routines scale, Mealtime routines scale, WHO-5 scale). The data was anonymous, whereby participants could only be identified by a code including the date and time the questionnaire was completed e.g. (27/03/2017 00:00:00). The original study was approved by the Ethics committee under code: ER/NF97/4.

# Chapter III

## **Results:**

### **3.1 Descriptive Statistics:**

Table 1 in Appendix A1 depicts the descriptive statistics for all variables. Items demonstrate high negative skewness, and both platykurtic and leptokurtic distributions, indicative of non-normality. Boxplots and z-scores indicated no outliers. Furthermore, K-S tests were all significantly non-normal (HC scale: D (225) = 0.122, p < 0.05, BR scale: D (225) = 0.101, p < 0.05, SES scale: D (225) = 0.119, p < 0.05). Frequency distributions of the responses to the HC and BR scales are denoted in Figure 3 and Figure 4.

Figure 3: *Frequency distribution for responses to the CHAOS scale:*

*Figure 3 (Appendix B): Frequency distribution of responses to the six questions on the CHAOS scale. Responses ranging from ‘Strongly disagree’, to ‘Strongly agree’ are listed, with corresponding number of participants who responded with each category.*

Figure 4: *Frequency distribution for responses to the Bedtime Routine scale*

*Figure 4 (Appendix C): Frequency distribution for responses to the 7 BR scale items*

Overall, assumptions of normality were violated, and thus a robust measure of EFA is required. However, it is important to note Likert-type data does not generally generate normally distributed data (Sullivan and Artino, 2013).

## **3.2 Is the sample size adequate for conduction of EFA and CFA?**

A Spearman’s rank correlation table was produced (Appendix D, Table 2). The determinant of the correlation matrix was 0.033, above the necessary value of 0.00001. Bartlett’s test was highly significant, *X*² (120) = 693, *p <* 0.001. Additionally, the KMO was calculated to be 0.74, ‘good’ for running EFA (Hutcheson and Sofroniou, 1999). Cronbach’s alpha tests were conducted on the HC scale and the BR scale with alpha values of 0.71 and 0.60 respectively.

## **3.3 RQ1: What EFA model best fits the data according to items on the CHAOS and Bedtime Routine questionnaires?**

Horn’s Parallel analysis (1965) was run according to ML method (Appendix E Figure 5). The output suggested that a four Factor extraction would be most suitable for EFA. An EFA according to ML was run with ‘oblimin’ rotation with four factors (Appendix F, Table 3). This model was unsuitable due to an Ultra-Heywood’s case being present (Cumulative variance of 102%), and not having at least two items loaded onto each factor (Isaac and Michaels, 1997).

A three-factor extraction was carried out instead with an ‘oblimin’ rotation (Appendix G, Table 4). Factor 1 was named ‘Screen Absence’, Factor 2 ‘Household Chaos’ and Factor 3 ‘Bedtime Organization’ respectively.

The total cumulative variance explained by the model was 62%, Factor 1 explained 31% if the variance, Factor 2, 12% and Factor 3, 23%. The three-factor model was the best model for this data set.

**3.4 RQ2: What are the dimensions of the final EFA model underlying the CHAOS and Bedtime Routine questionnaires? Do any demographic variables load onto any factor?** Figure 6 below highlights the final three-factor EFA model.

A close up of text on a white background

Description automatically generatedFigure 6

Figure 6 (Appendix H): Three factor, 12 item model. Dotted lines represent a negative correlation, while bold lines represent a positive correlation. All factor loadings +-0.3 are included. Further details (Appendix H)

Items on the CHAOS and BR scale loaded primarily onto two separate factors, as anticipated. However, ‘Screen Absence’ consisted of item ‘hc4’, ‘hc5’ and ‘Mother Education’. This factor correlated modestly with both ‘Bedtime Organisation’ and ‘Household Chaos’. The only demographic variable that displayed factoring was ‘Mother Education’ (0.31).

## **3.5 RQ3:** **‘Can Confirmatory Analysis validate the EFA model? What final CFA model is best fitting to the data?**

The three factor-12 item EFA model was run according to CFA (Figure 6).

*A picture containing game

Description automatically generated*Figure 7:

Figure 7 (Appendix I): A complex, triple-factor model of the CHAOS (N=225), BRS (N=225), and demographic item ‘Mother Education’. It includes 12 variables with their corresponding error variances (eg. e4).

The model demonstrated in Figure 7 possessed a ‘good’ GFI of 0.921, an RMSEA of 0.076, which is below 0.08 indicative of good fit (Cangur and Ercan, 2015), and a significant Chi-squared of 120.1 (52), (*p*<0.00). Nevertheless, the model item ‘hc4’ possesses a factor loading above -+1.0, and a negative error variance of -.105, indicating an ultra-Heywood’s case is present, which renders the three-factor model unsuitable.

Therefore, a novel CFA model was produced with the exclusion of the problematic factor ‘Screen Absence’ and its items (Figure 8):

A picture containing drawing

Description automatically generatedFigure 8 *Final two factor CFA model*

Figure 8 (Appendix J): A double-factor model of the CHAOS (N=225) and the BR scale (N=225).

This final model included a ‘good’ GFI of 0.94, an ‘acceptable’ RMSEA of 0.085, and a significant Chi-squared statistic of 68.21 (26), (*p*<0.00)

# Chapter IV

**Discussion:**

This secondary analysis aimed to interrogate and validate the Household Chaos and Bedtime Routine questionnaires according to the importance of items on both questionnaires to their subsequent latent constructs. Additionally, demographic characteristics were assessed in terms of factorability and relationships to both constructs, and whether they could explain variance present within the data that were not already explained by the items on the questionnaires. This could influence theoretical understanding of chaos and bedtime routines in young children. This section highlights a) the main findings of the factor analysis (research questions, hypotheses), b) Household Chaos, c) Bedtime Routines, d) Implications for measuring latent constructs, e) Future recommendations and f) Limitations.

## **4.1 Summary of Main Findings:**

In relation to the first research question – ‘What EFA model best fits the data according to items on the CHAOS and Bedtime Routine questionnaires?’, exploratory factor analysis revealed a three factor-twelve item model as being best fitting to the data. The null hypothesis was approved, and the hypothesis that a two-factor solution is best fitting was rejected. This is due to the presence of an unexpected new factor, ‘Screen Absence’, that correlated with both constructs Household Chaos and Bedtime Organisation. The EFA model explained a total of 62% of the variance, which is which is above the required value of 50% and is considered acceptable (Hair, Sarstedt, Hopkins and Kuppelwieser 2014). However, it is important to note that the model did not explain 38% of the variance within the data. The first research question highlights the need for more research underlying the construct Screen Absence and how this may influence both Household Chaos and Bedtime organisation on a theoretical basis.

The second research question included: ‘What are the dimensions of the final EFA model underlying the CHAOS and Bedtime Routine questionnaires? Do any demographic variables load onto any factor?’. The null hypothesis was approved, and the hypothesis rejected, as not all questionnaire items loaded onto their corresponding factor. Items br5 and br7 did not load onto any factor. The only demographic factor which demonstrated factorability was ‘Mother Education’. This demonstrated a low factor loading of <0.4, as estimated.

The third research question involves: ‘Can Confirmatory Factor Analysis validate the EFA model? What final CFA model is best fitting to the data?’ The CFA model did not confirm the 3-factor, 12-item model, and revealed a 2-factor and 9-item model, which was best fitting to the data, thus the null hypothesis is approved, and the hypothesis that CFA can confirm the EFA model is rejected.

## **4.2 Measurement of Household Chaos:**

Studies suggest that Household Chaos involve components of a disorganized environment, high in background stimulation or noise, an absence of routine and life predictability, and crowding (Wachs and Evans 2010). This has been linked to a range of adverse outcomes including poorer cognitive development, socio-emotional wellbeing, parental wellbeing, child academic achievement and physical wellbeing (Evans 2006, Deater -Deckard et al. 2009).

The results of the factor analysis can allow for conclusions to be made on the importance of items in measuring the construct of household chaos. This can provide further insight into a theoretical and mechanistic understanding of chaos within the home.

**Background Stimulation/Noise:** Excessive noise within the household has previously been identified as being a crucial indicator in measuring levels of chaos within a household. The mechanisms of which children’s development is impacted due to noise is not fully categorized; however, Martin, Razza and Brooks-Gunn (2012) suggest that children who are exposed to chronic noise are vulnerable to poor reading and language development due to having to filter out both useful and background auditory stimuli. The item on the CHAOS questionnaire “You can’t hear yourself think in our home” is suggestive of high levels of background noise within the household, and the factor analysis demonstrated that it is the most crucial indicator of chaos within the household, with a factor loading of 0.74.

These detrimental impacts of noise typically relate to modulatory noise, such as speech (Herweg and Bunzeck, 2015). This is due to information processing typically being disturbed by other items that are not related to a task. For example, a child carrying out a piece of homework may struggle due to background speech noise, e.g. siblings arguing, and may make it difficult for the child to process information and carry out the task efficiently. On the other hand, white noise has been demonstrated to improve task performance in inattentive children, and not attentive children. Children with ADHD demonstrate increased concentration capabilities in certain circumstances when listening to white noise while carrying out a task. (Helps, Bamford, Soruga-Barke and Soederland, 2014). Dopamine regulation modulates internal noise and can be used to explain such differences in attentiveness and task performance (Moss, Ward and Sannita, 2004).

Hard of hearing children form a significant population whereby background noise may be detrimental to learning. The signal to noise ratio is significantly different, where a deaf or hard of hearing child requires a signal to noise ratio of +20 to +30 dB compared to +16 in a child with normal hearing capacity (Nittrouer et al. 2013). Signal to noise ratio is crucial in speech recognition and is related to listening effort.

This study demonstrates that background noise is a crucial component in measuring chaos within the household and supports definitions provided by Evan and Wachs (2010).

**Screen Usage:** The CHAOS Questionnaire contained two questions relating to screen usage: hc4: “There is usually a TV turned on somewhere in our home”, and hc5: “We limit Screen time e.g. (iPad time) in our home.”

Screen usage has been previously recognized as being linked to adverse factors including obesity, decreased psychological wellbeing and poorer sleep time/quality (Babic et al. 2017, Emond et al 2018, Hale et al. 2019, Przybylski 2019). Both items hc4 and hc5 demonstrated significant spearman’s correlation coefficients with hc1, hc2, hc3 and hc6 (Appendix D, Table 2), however not mutually. Additionally, hc4 and hc5 did not factor onto any latent constructs in the final CFA model. This contradicts previous findings that having a TV turned on in the home regularly and screen absence is closely linked to household chaos (Bonfrenbenner and Evans et al. 2000, Johnson, Martin, Brooks-Gunn and Petrill 2009, Emond et al. 2018). Screen time has also been linked to maternal education level (Atkin, Corder and van Sluijs et al. 2013). The sample had a higher than average maternal education level with the equivalence of an undergraduate degree. A high average maternal education could have moderated the negative impact of screen usage. Maternal Education correlated strongly with hc4 (*r* = -.0195, p<0.01), indicating that this is a possibility. Therefore, this study does not support the usage of items relating to screen use in the measurement of household chaos and suggests this construct should be regarded as an entity of its own, despite having significant correlations items relating to household chaos.

Additionally, the quality of screen usage has not been explored sufficiently and is not specified in the context of the CHAOS and Bedtime routine questionnaires. Constructive usage of screen time, i.e. for e-learning may potentially prove less of a hindrance in terms of screen time than non-educational programs due to a lack of cognitive stimulation. However, screen use, particularly at bedtime, would theoretically hinder sleep quality and quantity similarly, due to same amount of light exposure and similar melatonin suppression (Hale et al. 2019).

**Physical Crowding:** Physical crowding within the home has also been linked to increased amounts of chaos within the home (Evans and Wachs, 2010). This is a dimension that is currently not part of the six-item CHAOS questionnaire. Number of siblings has been previously suggested to be an accurate measure of physical crowding within the home (Matheny, Wachs, Ludwig and Phillips 1995). Physical crowding was investigated in this study in relation to the number of children within the home, which ranged from 1-4 children. This variable significantly correlated with hc1 (*r* =.195, p < 0.01), and hc2 (*r* = .170, p < 0.05), however did not load onto any factor in the factor analysis. Conclusions were drawn that number of children within households does not aid in the measurement of chaos. This contradicts the notion that physical crowding is an important component of household chaos. There are several reasons why this may have been the case, and they relate specifically to population differences. Firstly, the range of number of children within the household was not large, with a maximum of four children. Additionally, the range of household population may have not been large enough to provide factoring.

One can attest that higher household income families may be more likely to live in houses with higher than average spacing (sf.), which may mediate the effects of the number of people within the home. Previous studies demonstrate that components of chaos (e.g. Crowding, noise) can act as a mediating variable in associations between poverty and socioemotional competencies (Brody and Flor 1997, Evan and Kim 2007).

However, as Marsh, Dobson and Maddison (2020) describe, household chaos is linked and is influenced by many demographic variables but is a unique risk factor in adverse child outcomes including socioemotional vulnerabilities. When controlling for variables including, maternal education, SES, parental warmth, and housing status, household chaos can still result in adverse outcomes including reduced cognitive ability and IQ (Deater-Deckard, 2009).

In summary household chaos is described by its unique components of background noise and parental perceptions of chaos within the home and demographic influences such as physical crowding, maternal education and household income did not play a role in accounting for the unexplained variance within the data.

Therefore, this factor analysis highlights that targeting perceptions of chaos and background noise within the home is paramount to reducing stress and overall chaos.

## **4.3 Measurement of Bedtime Routines:**

**Regularity and Structure:**

The factor analysis revealed that the regularity and structure relating to bedtime routines are of paramount importance in measurement of bedtime routine organisation. Items which demonstrated factoring relating to regularity and structure involved br1 (‘Bedtimes are at the same time every day’), br2 (‘The children have a regular bedtime routine’), br4 (‘The children are regularly read stories at bedtime’). These 3 items all contained elements of regularity and consistency in bedtime routine structure. They demonstrated factor loadings of >0.4 which is essential for questionnaire use as stated in section 2.4 and support the study by Nicola fuller (2017) in that these variables indeed provide a viable measure of bedtime organisation and routine.

Regularity appears to be a recurring theme within the literature and relate to essential components of bedtime routines (Mindell, Li, Sadeh, Kwon and Goh 2015, Kitsaras, Goodwin, Allan, Kelly and Pretty 2018). In children who demonstrate sleep disturbances as a result of poor bedtime routine implementation, Mindell et al. (2017) demonstrate that these consequences can be alleviated and fully eliminated after a few days of implementation of consistent bedtime routines.

**Distraction:** Item br3 (‘It is important to turn off distractions (e.g TV) at bedtime’) proved to be an important factor in the evaluation of bedtime organisation in young children. This evidence supports current literature in that the use of electronics at bedtime is detrimental to sleep health. Hale and Guan (2015) demonstrate that 90% of studies on bedtime routines and electronics suggest significant interactions between screen use and delayed or decreased sleep time. Mechanisms suggested in this study include light exposure and physiological alertness and displacement of sleep time. Thus, parental perceptions of turning off distractions at bedtime (whereby electronics pose most distracting) is paramount to measuring bedtime routine within the home.

**Resistance:** Resistance of children during bedtime, br6 (‘The children resist going to bed at bedtime’) was negatively linked to overall bedtime organisation, with a factor loading of -.49. Bedtime resistance is a common phenomenon, particularly with younger children and toddlers, and manifest by bedtime refusal, difficulty waking, and sleepwalking (Blader et al. 1997). Arora (2019) links bedtime refusal to difficulties at bedtime, however, there are bidirectional linkages between these constructs. Thus, bedtime refusal is both a consequence and a cause of poor bedtime routines. Therefore, when measuring bedtime organisation, refusal is an indication of poorer bedtime structure. Br6 was additionally significantly linked to increased household chaos scores (hc1, r = .203\*\*, hc2, r = .236\*\*, hc4, r = .209\*\*, hc6, r = -.245\*\*). It also correlated with reductions in bedtime organisation scores (br2, r = -.367\*\*, br3, r = -.242\*\*, br5, r = .303\*\*). Although causation cannot be inferred from the factor analysis, chaos and bedtime organisation scores are clearly directly correlated based on their spearman’s correlation coefficients.

**Story reading:** Items on the BR scale that related to story reading included br4 (‘The children are regularly read stories at bedtime’), br5 (‘The children are regularly read stories at other times of the day’), br7 (‘The children ask to hear stories they’ve heard recently’). Only br4 factored onto bedtime organisation. This is due to this item relating specifically to bedtime and supports the Factor Analysis techniques reliability. Br4 was linked to household income, suggesting that the greater the household income, the more likely stories are red to children at bedtime. This supports Hale, Berger, LeBourgeois and Brooks-Gunn (2009), that children in poverty are more vulnerable to being subjected to a reduction in literacy development.

## **4.4 Implications for measuring latent constructs:**

Statistical analyses including EFA and CFA are paramount to the production and improvement of questionnaires within the psychological field. When carrying out factor analysis, several decisions must be carried out which dictates the credibility of the analysis. These decisions include selecting number of factors to retain, rotation, factor labelling, and type of extraction method. This study followed several resources to enhance the quality of the factor analysis. Watkins (2018) criticises certain researchers in psychology that use EFA and CFA, in that many applications of factor analysis are marked by incomplete reports and injudicious choices. This study tried to maximise the abilities of factor analysis and reduce potential bias. Watkins (2018) described several main steps which must be carried out: Careful inclusion of variables, Normality assessments, Data appropriateness for EFA, Estimation method selection, No. of Factors to retain, Rotation of factors, Interpretation of results. This study followed these specific procedures with care.

This study utilised three software’s, SPSS, RStudio and Amos (Structural Equational Modelling). SPSS proves to provide useful for general analyses relating to Factor Analysis, however this study strongly advises the usage of RStudio for EFA in specific circumstances, and Amos (Structural Equational Modelling) for CFA. SPSS was attempted for the EFA, however due to analysing non-parametric data, SPSS proved to be more complicated in accounting for the need for inputting a Spearman’s Rho correlation matrix, which is advisable in this instance (de Winter. Gosling and Potter, 2016). It is however possible (Ritter, 2012).

All in all, when carrying out factor analysis, careful steps need to be followed in order to maximise the result and validity of the factor analysis.

## **4.5 Limitations:**

There are several limitations of this current study. Firstly, factor analysis posses’ methodological disadvantages in that names applied to latent constructs can differ according to researchers’ perceptual differences, and thus could lead to incorrect factor labelling and subjectivity (van der Eijk and Rose, 2015). However, in this study, the factor analysis involved two know constructs, ‘Household Chaos’ and ‘Bedtime Organisation’ and thus supports a more objective approach regarding factor labelling. Secondly, the data reduction process requires reducing a large data set into smaller factors, thus some data can be excluded from the analysis that may play a small role in explaining some of the variance within the data, and these may have been unaccounted for in the final model. For example, significant correlations demonstrated in the spearman’s correlation table (Appendix D, Table 2) show significant correlations between items, which did not load onto the final model. Additionally, causal inferences cannot be made with factor analysis. The analysis simply assesses whether items on a questionnaire measure the construct they intend to measure.

This study relied on self-report questionnaires. Self-reported parenting and parental perceptions can significantly differ from observed, due to factors such as personality (DeCastellarnau, 2018) and can reduce ecological validity of the study. The 6-item CHAOS scale demonstrates a slightly reduced reliability to the 15-item scale. Additionally, the analysis did not explain all the variance within the data posits a need for further exploration of other items which could explain more variance within the data. This study also contained secondary data that violated normality; however, this was counteracted with usage of Spearman’s correlation coefficients rather than Pearson’s.

Another limitation of this study relates to sampling demographics, which consisted of primarily white-Caucasian British participants who were primarily women, thus the study lacks generalisability to a wider multicultural group and reduces influence of paternal perceptions of chaos within the home, which could be different to their paternal counterparts. When constructing or improving questionnaires that measure specific constructs, these questionnaires must be evaluated and tested in varying cultural context, in order to assess generalisability to the population. In specific circumstances, questionnaires must be modified in order to suit specific circumstances. An example of this is, when assessing children for autism spectrum disorder (ASD), girls do not match typical criteria for ASD, as the criteria was originally made to quantify symptoms in boys (Ratto et al. 2018). The same principles may have to be applied to the CHAOS and Bedtime Routine scales, whereby these questionnaires could potentially require modification to suit different demographic and cultural needs. However, a Malay version of the CHAOS has demonstrated success, and further exploration is warranted in this area (Ganasegeran, Selvaraj and Rashid, 2017).

## **4.6 Future research recommendations:**

Firstly, application of factor analyses in different cultural and demographic contexts should be considered, as stated in section 4.5, to ensure fidelity of both the CHAOS and Bedtime Routine Questionnaires and establish more credibility within a wider population. This can inform whether these scales are appropriate across different populations and whether any modifications are required. Since the BR scale is relatively novel and its Cronbach’s alpha reliability score has room for improvement (*a* = 0.60), this suggests targeting this scale in particular, for novel variables, or modification of variables that may improve the scale and explain more of the variance within the data.

As stated previously, investigation into other aspects of bedtime routine measurement is required. These components could include more specific aspects of bedtime routine, involving criteria set out by Mindell and Williamson (2018), including items measuring physical contact, hygiene behaviours, communication and nutrition. The current bedtime routine questionnaire (Fuller, 2017) does not measure components including nutrition, hygiene behaviours and physical contact, and could potentially explain the missing variance, and improve reliability of the scale. Addition of these variables should be implemented, and a factor analysis carried out with novel data.

Regarding the CHAOS, the results suggest that two items relating to screen usage did not factor onto the construct ‘Household Chaos’ in the final CFA model, therefore future research regarding the measurement and impact of more specific elements of screen use (time spent on screens, type of media and media content) may provide more insight into the point at which screen usage becomes important in the measurement of chaos within households which could explain the variances with this study, and previous studies supporting the use of ‘screen usage’ variables in the measurement of chaos.

## **4.7 Conclusions:**

This study sets forth a precedent for supporting the continuation of usage of the BR scale, in that it recognises the essential contributions of the themes ‘bedtime structure/regularity’ and ‘story reading’ at bedtime in measuring bedtime organisation. Additionally, measuring levels of ‘distraction’ and ‘bedtime resistance’ are also crucial in measuring bedtime organisation. There is room for improvement of the reliability of BR scale (*a* = 0.6)

Relating to measurement of household Chaos, the final model consisted of factor loadings of only 4 out of the 6 items measured on the CHAOS. The two items that did not display factoring involved the concept of ‘Screen Use’. This indicates that screen usage may not pose useful enough in the measurement of Household Chaos and contradict previous findings (Matheny, 1995, Emond et al. 2018). This suggests that screen use should be recognised as a separate entity, and not for use within the measurement of CHAOS within the home. Further research in this area is required to probe this matter, particularly within populations of different cultural and socioeconomic backgrounds. No demographic variables factored onto the final CFA model, and therefore were not essential in the measurement of both ‘Household Chaos’ and ‘Bedtime Organisation’.

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