THE RELATIONSHIP BETWEEN SLEEP AND MIND-MINDEDNESS IN NEW MOTHERS

by

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Thesis Overview

This thesis is presented in two parts: a meta-analysis and an empirical study. The aim of the research papers was to address the existing gaps in the literature related to mind-mindedness and its relationship with attachment security, and its potential to be impacted by sleep deprivation in new mothers.

The meta-analysis aimed to synthesise the literature on the relationship between mind-mindedness and attachment. Analysis found that there is a relationship between appropriate mind-mindedness and a more secure attachment. Conversely, non-attuned mind-mindedness has shown to be associated with more insecure attachment styles. Yet, no differences were found between the subgroups of insecure attachment. Subgroup analysis found no differences in assessment measure or gender.

The empirical study used a within subjects' design to measure the relationship between sleep changes and mind-mindedness in new mothers. Non-attuned mind-mindedness was positively associated with an increase in wake after sleep onset.

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Abstract

Rationale

Understanding both attachment and mind-mindedness constructs can offer insight into the development of a person's cognition, personality, and relationships. Numerous studies have indicated an association between mind-mindedness and attachment with maternal mind-mindedness explaining between 6.5-12.7% of the variance between attachment styles. As yet, there is no meta-analysis which synthesises the data for this relationship.

Method

A search of five databases (Medline, ERIC, Cochrane Library, PsycINFO, Web of Science) was completed and following predetermined inclusion and exclusion criteria, 31 papers were identified for review. Two study designs were identified and evaluated: group level data and correlational. A total of 43 effect sizes for appropriate mind-mindedness and 28 effect sizes for non-attuned mind-mindedness were subjected to multilevel meta-analysis. Gender and assessment measure variables were subjected to subgroup analysis.

Results

Appropriate mind-mindedness was shown to be associated with more secure attachment; SMD = 0.46 (95%CI: 0.26 to 0.66), r = 0.13 (z = 2.77, p = 0.0056; 95%CI: 0.04 to 0.21).

Non-attuned mind-mindedness was shown to be associated with more insecure attachments; SMD = -0.65 (95%CI: -0.99 to -0.31), r = 0.09 (z = -1.30, p = 0.19; 95%CI: -0.21 to 0.04). Analysis indicated no difference between insecure subgroups, for either mind-mindedness category. No difference was found in the relationship when considering assessment measures of both constructs and the gender of the parents.

Discussion

The results indicated that there is a relationship between mind-mindedness and attachment security, consistent with the consensus of previous literature. These results indicate that attributing internal states that appear to be consistent with an infant's current experience could be important in nurturing a secure relationship. Conversely, attributing internal states that appear to be at odds with an infant's current experience may suggest a disconnect between the parent and child; this could potentially influence their developing relationship. However, further exploration is needed on the nuances within this construct as well as possible variables such as gender, age, and social economic status.

Introduction

Attachment security is known to have broad and long-standing influences on how a person interacts with others and navigates the world around them, significantly impacting on their quality of life (Darban et al., 2020). Mind-mindedness was proposed as an alternative view to maternal sensitivity, to explain some of the variance in attachment security (Meins et al., 2001, 2003). A predictive relationship has been proposed between caregivers' use of appropriate, mind-related comments and secure attachment (Arnott & Meins, 2007; Laranjo et al., 2008; Lundy, 2003; Meins et al., 2001).

Attachment

Attachment theory developed with a major focus on the parent-child relationship, proposing that a predominant attachment style develops during an infant's first year (Ainsworth et al., 1978; Bowlby, 1988). Bowlby (1988) described securely attached children as using attachment figures for support in times of need, or as a secure base from which to explore. However, there is much variance in parents' responsiveness, availability, and approach to caregiving; children who need to learn to interact with more unresponsive or unavailable caregiving are more likely to develop an insecure attachment (Ainsworth et al., 1978; Bowlby, 1988). Insecure attachment is characterised by inconsistency and rejection. The Strange Situation aims to categorise infants into one of four attachment styles: secure, insecure-avoidant, insecure-resistant (Ainsworth et al., 1978), and insecure-disorganised (Main & Solomon, 1986), based on their interactions with their caregivers.

Consequences of Attachment Security

Early parent-child relationships have long-term consequences on the child's psychological and physical health (DeKleyn & Greenberg, 2008; Lyons-Ruth & Jacobvits, 2008). Attachment style goes some way to describe individual differences in a child's development, with secure attachment acting as a protective factor for a child's mental health, and insecure attachment predicting childhood depression (Allen et al., 2007; Spruit et al., 2021). Individuals with insecure attachments can struggle to manage negative life events and affect regulation (Mikulincer & Shaver, 2012b; Sutton, 2019). These individuals also have an increased risk of conduct problems and substance misuse (Oshri et al., 2015; Starks et al., 2015; Vando et al., 2008). Furthermore, secure attachment has been shown to be related to greater commitment and stability in romantic relationships (Sutton, 2019). To summarise, attachment style can play a key role throughout an individual's life, with secure attachment positively predicting quality of life (Darban et al., 2020).

Predictors of Attachment Security

Understanding a person's attachment style can offer insight into their personality, cognitive development, and the way they relate to others, highlighting areas of difficulty that may require additional support or skill development. However, the interconnected components predicting attachment security continue to be investigated. A core hypothesis is that attachment patterns can be passed down through generations and parental narrative around attachment predicts child attachment (Ainsworth et al., 1974; Bernier & Dozier, 2003; McMahon & Bernier, 2017; Zeegers et al., 2020). This transgenerational attachment is in part mediated by parental sensitivity (van IJzendoorn et al., 2004; van Ijzendoorn & Bakermans-Kranenburg, 2019). Parental sensitivity is defined as the parents' ability to

notice, interpret, and respond to a child's signals, typically behavioural aspects, appropriately and promptly (Ainsworth et al., 1974; Planalp et al., 2019). However, sensitivity is estimated to account for approximately only 25% of the variance in attachment security, with the other 75% remaining unexplained; this is referred to as the 'transmission gap' (McMahon & Bernier, 2017). Mind-mindedness proposes an alternative way of viewing maternal sensitivity in an attempt to bridge some of the 'transmission gap' (McMahon & Bernier, 2017; Meins, 1999; Meins et al., 2001).

Mind-Mindedness

Drawing upon attachment and social-cognitive theories, Meins (1999 & 2013) proposed the concept of mind-mindedness. Mind-mindedness relates to the construct of mentalising, through which parents demonstrate their ability to tune into their child's mental state (Meins, 2013; Zeegers et al., 2017). Mentalising refers to the ability to understand and reflect on one's internal state of mind in order to have insight into what they may be feeling and why. Parental sensitivity is the quality whereby a parent tunes into their child's signals (typically behavioural aspects) that may indicate a particular internal state and then respond to such signals appropriately (Ainsworth et al., 1974; Planalp et al., 2019). Yet, meta-analyses have only observed modest relations between parental sensitivity and attachment (de Wolff & van IJzendoorn, 1997). Due to such modest results and that sensitivity involves a broad range of components within the parent-child relationship and subsequent interactions, there have been efforts to update and refine this construct (McMahon & Bernier, 2017; Planalp et al., 2019; Van IJzendoorn, 1995). Mind-mindedness was developed in an attempt to refine parental sensitivity, focusing on the cognitive component of the broader sensitivity construct (McMahon & Bernier, 2017; Meins, 1999, 2013). As

such, Sharp and Fonagy (2008) conceptualised mind-mindedness as an operationalisation of parental mentalising within parent-child relationships, with Meins et al. (2003, 2014) expanding that mind-mindedness is a quality of close relationships. This is supported with evidence that more mind-mindedness is used to describe those of a close relationship (child, romantic partner, friend), compared to a famous person (Hill & McMahon, 2016). However, Meins et al. (2003, 2014) state that mind-mindedness is distinct from mentalising, in that it is an individual's spontaneous use of their mentalising to interact with others, rather than their basic capacity to understand others' mental states. This distinction is supported by Barreto et al. (2015) who explored the relationship between mentalising abilities and mind-mindedness in mothers and fathers. Therefore, mind-mindedness is conceptualised as a more relational quality whilst mentalising appears to reflect a more basic cognitive-behavioural competence. As such, it is hypothesised that one's mind-mindedness is not a fixed state and research has begun to explore the impact of interventions on this construct (McMahon & Bernier, 2017; Schacht et al, 2017). Parental mind-mindedness has also been related to a child's cognitive development; the strongest associations are with social cognition, executive functioning, and language domains (Aldrich et al., 2021).

Mind-Mindedness and Attachment

Mind-mindedness has shown to make independent predictions on parent-child attachment security, with maternal mind-mindedness explaining 6.5-12.7% of the variance between attachment styles (Bernier & Dozier, 2003; Meins et al., 2001; Zeegers et al, 2017). More appropriate mind-related comments have been associated with more secure parent-child relationships. Fewer appropriate mind-related comments have been associated by those displaying non-secure attachment styles (Arnott & Meins, 2007; Dollberg, 2022; Lundy,

2003; Meins et al., 2001, 2018). However, evidence is inconsistent, with several studies reporting no association between attachment security and maternal mind-mindedness (Arnott & Meins, 2007, 2008; McNamara et al., 2021).

Studies investigating this relationship in clinical samples have produced mixed results. Bigelow et al. (2018) found that mothers at risk of depression were less appropriately mind-minded despite decline in depression risk reducing at time of parent-child interactions. This relationship in turn was associated with infants' degree of disorganised attachment 6 months later. Similar results have been found by Pawlby et al. (2010) and Schacht et al. (2017). Furthermore, Mothers with Borderline Personality Disorder proportionally made more non-attuned mind-minded comments compared to a control group but did not differ in appropriate mind-related comments (Marcoux et al., 2017). However, many studies have reported no significant correlation between mind-mindedness and current depression symptoms (Demers et al., 2010b & Meins et al., 2013).

Assessing Mind-Mindedness

Meins and Fernyhough (2015) laid out two approaches to assessing mind-mindedness that rely on the analysis of transcripts of speech. An observational measure is scored from a caregiver's verbal references to a child's internal state such as emotions, preferences, and goals during an unstructured interaction with the child (Meins et al., 2001; 2013; 2015). A second, representational measure (interview measure) invites caregivers to describe others and assesses their tendency to include mental states in their response (Meins et al., 2014). The index for mind-mindedness is the score for the mental attributes provided by the caregiver, calculated as a proportion of the total number of comments (Meins & Fernyhough, 2015).

Observational Measure

Up to the age of 12 months, mind-mindedness is operationalised as a caregiver commenting appropriately, or in a 'non-attuned' way, on the child's presumed internal state during an unstructured interaction (Meins et al., 2001). An appropriate mind-related comment refers to a current activity, an inference to a child's internal state that the researcher agrees with and a comment clarifying how best to proceed. A non-attuned, mind-related comment refers to when the caregiver does not seem in tune with the child's current states. For example, a caregiver saying "you like that" when the child has shown no interest in the object (Meins & Fernyhough, 2015).

Representational Measure

For children of preschool age and above, mind-mindedness has been assessed using a brief interview (Meins et al., 1998 & 2015). Interviews are transcribed verbatim and coded for mental attributes. Any comments that refer to the child's mental attributes, such as their mind, knowledge, and interests are coded as such, alongside five other categories (behavioural, physical, general, self-referential and placement). This measure has been adapted to assess mind-mindedness by inviting individuals to describe a friend, partner or a famous person (Meins & Fernyhough, 2015).

Previous Reviews

Zeegers et al. (2017) conducted a meta-analysis reviewing the relationship between attachment, sensitivity and parental mentalisation, including mind-mindedness. Exploring the use of observational assessments of attachment, the Strange Situation (Ainsworth et al., 1978) and Attachment Q-Set (AQS; Waters & Deane, 1985), parents' mentalisation abilities

have been shown to directly impact parent-child attachment and have an indirect impact via its effects on sensitivity. However, only five papers reported on mind-mindedness, and given the argument that mind-mindedness is distinct from mentalising (Meins et al., 2014) there may be some variance in the relationship between parental mentalisation and attachment, compared to mind-mindedness and attachment. Despite this, the review highlights the value in considering the tendency to engage with a child's internal states and not just responding behaviourally to the child's cues (Zeegers et al., 2017). Expanding upon this in the form of a narrative review, McMahon and Bernier (2017) highlighted the limited evidence of the relationship between mind-mindedness and subgroups of attachment, specifically non-attuned mind-mindedness. Furthermore, McMahon and Bernier (2017) concluded the representational measure of mind-mindedness is underrepresented in the literature and therefore we are yet to understand any nuances between free play and interview, that may influence attachment styles.

Rationale

Predicting attachment security can offer insight into the development of a person's cognition, personality, and relationship. However, most of the variance in the development of attachment security remains unexplained (McMahon & Bernier, 2017; Zeegers et al., 2017). Additionally, developmental abilities such as executive functions and language abilities have been associated with mind-mindedness (Aldrich et al., 2021). Numerous studies have indicated an association between appropriate mind-mindedness and secure attachment (Arnott & Meins, 2007; Lundy, 2003; Meins et al.,2001, 2018), and non-attuned mind-mindedness with insecure attachment styles (Meins et al., 2018). However, the literature is inconsistent, with multiple studies reporting no association between the two

constructs (Arnott & Meins, 2007, 2008; Dollberg, 2022; Hill & McMahon, 2016; McNamara et al., 2021; Szpak & Białecka-Pikul, 2015). Furthermore, the relationship between mind-mindedness and attachment subgroups remains unclear. Additionally, the variance between variables, such as the mind-mindedness measure or maternal vs paternal, has not yet been established.

Thus, the present meta-analysis aimed to synthesise the literature on the strength of the relationship between mind-mindedness and attachment security. Mind-mindedness is operationalised using the Meins & Fernyhough manual (2015). It was hypothesised that higher rates of appropriate mind-related comments would be associated with secure attachment. Following Meins et al. (2018), it was predicted that higher proportions of non-attuned comments would be associated with insecure attachment styles. The current review also aimed to explore variables in the literature, such as assessment measure, gender, age, socioeconomic status (SES) and education.

Method

Literature Search

A scoping search was conducted on 10th September 2021; as a result, this review was preregistered on PROSPERO (2nd December 2021, CRD42021282863). A systematic search of five databases (Medline, ERIC, Cochrane Library, PsychINFO, Web of Science) was conducted on the 22nd of March 2023, using the terms "mind-mindedness" and "mind mindedness". Following Aldrich et al. (2021) and McMahon and Bernier (2017), no additional restraints were made on any database to obtain a comprehensive overview of mind-mindedness, from the earliest record. The reference lists of key papers and existing

reviews (Aldrich et al., 2021; McMahon & Bernier, 2017; Zeegers et al., 2017) were reviewed to identify any additional relevant papers; none were found.

Study Selection

Studies were considered eligible for inclusion if they met the criteria in Table 1. In order to gain a holistic view of the relationship between mind-mindedness and attachment, the meta-analysis included papers on adults and adult attachment (e.g., undergraduate students) as well as parent-child attachment studies.

Table 1.

Meta-Analysis Inclusion Criteria

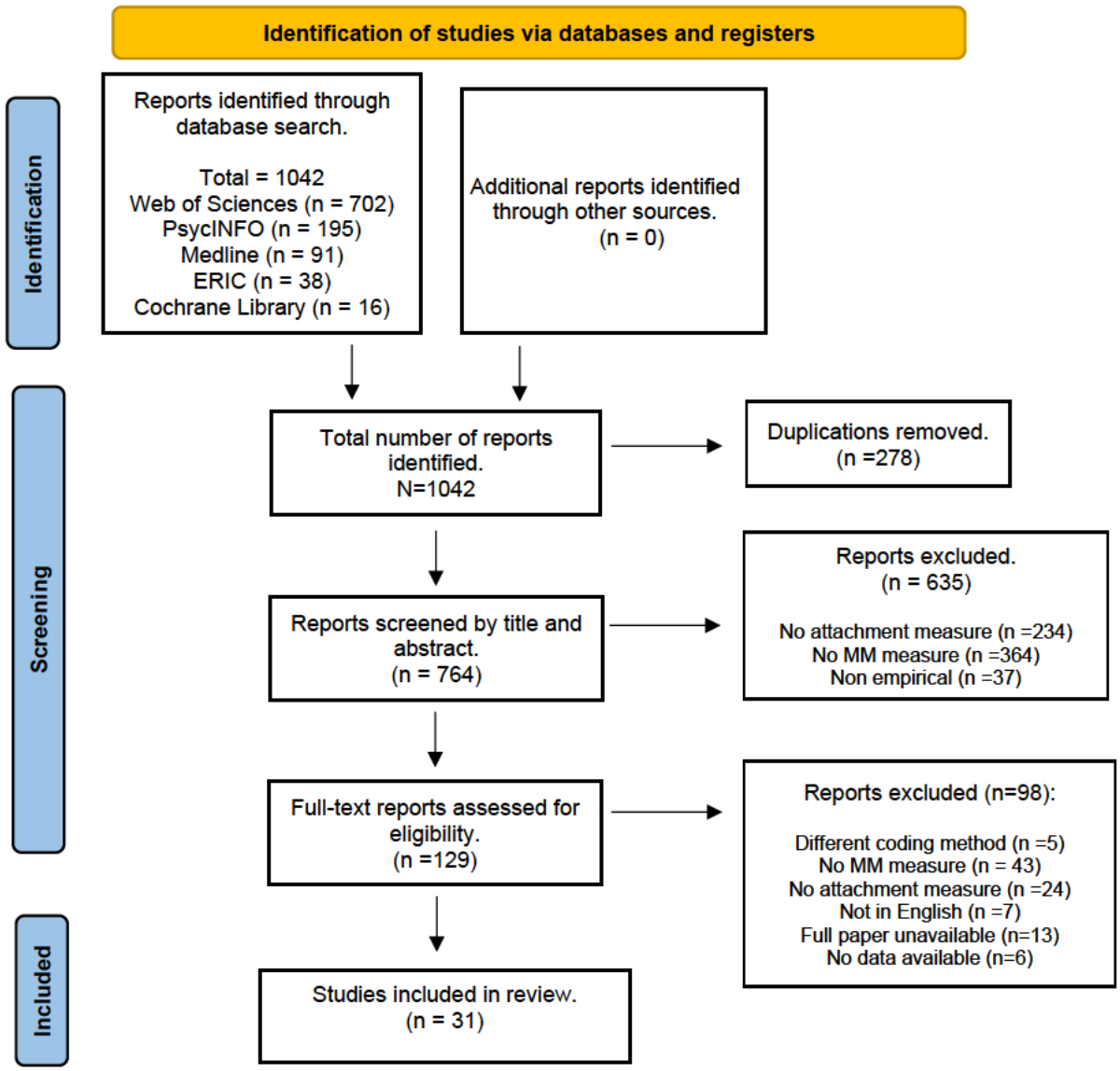
Inclusion criteria
Quantitative empirical studies
MM as coded by Meins & Fernyhough manual (2015), or earlier version
Association reported between MM and attachment
Papers available in the English language
Full text available

Note. MM = Mind-Mindedness

The search and selection processes are shown in Figure 1. All the below steps were re-run by an additional researcher, providing good inter-rater reliability. The percentage agreement for data extracted was 93.2%, and the Kappa was calculated as $k = 0.81$, indicating an excellent level of inter-rater agreement (Cohen, 1960). Thirty-one studies satisfied the criteria for inclusion in the meta-analysis; the references of these papers and existing meta-analyses were examined for any additional studies that met the inclusion criteria. No additional studies were found.

Figure 1.

PRISMA flow diagram showing the results of the systematic review search and application of exclusion criteria.



Study Design

Two main study designs were identified: group level data and correlations between mind-mindedness and attachment. Fifteen papers included correlations between attachment and mind-mindedness. Nine studies included group mean differences. However, these studies varied in how they reported on attachment, splitting attachment into subgroups of two

(secure/insecure), three (secure/ anxious/ avoidant) or four (secure/ anxious/ avoidant/ disorganised). Studies that reported different designs that were not possible to meta-analyse were included in the Narrative Review of this thesis.

Quality Review

A set of quality criteria was developed to assess each study's quality and risk of bias (Table 2). The quality criteria were designed to measure the methodological limitations of a study in relation to the question of the meta-analysis, such as problems with the sample, measurements of attachment or mind-mindedness. Papers were attributed a score: 0 (high risk) – 3 (low risk) across five risk factors. The overall quality index for each study was then calculated as the mean of the scores across all factors. Two factors referred to the reliability and validity of measures used in the studies. These were the measurements of mind-mindedness and attachment, respectively. In terms of mind-mindedness, studies were rated excellent if they used a mind-mindedness measure as outlined in Meins and Fernyhough (2015), with the specified population. Due to the continued development of this concept, studies that adapted such measures for alternative age groups or clinical populations were included and rated as adequate. Future analyses may wish to reconsider this with the publication of new findings and amendments of the manual. In relation to attachment, studies were considered excellent if they used a validated observational method with good interrater reliability. Studies were rated as good if a validated questionnaire was used, or an observational method with less than 20% inter-rater, or $k < 0.80$.

One factor of the quality framework was related to sampling, with a random sample being rated as excellent. However, due to the population being investigated, studies are unlikely to include a truly random sample. Therefore, a good rating was applied to those studies who

recruited participants from multiple sources, such as multiple healthcare clinics and parent-and-baby groups.

The final factors referred to the reporting of the study in terms of the detail included, allowing the methodology to be replicated and all aspects of the analysis reported clearly. It should be noted that these ratings reflect the quality of the study in reference to the specific question of this meta-analysis and therefore does not reflect the quality in reference to the author's original question. A random selection of 20% of the papers were assessed by a second rater with 86% interrater agreement.

Table 2.

Risk of Bias Quality Framework

Item	Poor (0)	Adequate (1)	Good (2)	Excellent (3)
Measure of Mind-Mindedness	Unspecified	Other assessment methods utilised but coded using the Meins & Fernyhough 2015. MM assessment adapted from validated manual (Meins & Fernyhough, 2015). May include with population, age group not yet validated.	MM as coded by Meins & Fernyhough 2015. Less than 20% 2nd rater or adequate inter-rater reliability reported k=0.61-0.80.	MM as coded by Meins & Fernyhough 2015 (or earlier manual). 20% + rated by second coder & good inter-rater reliability reported $k \geq 0.81$.
Measure of Attachment	Unspecified or unable to replicate.	Clearly described Unvalidated. Could be replicable. Validated measure with less than adequate interrater reliability $k<0.61$.	Validated questionnaire or interview, note any form of validation is applicable. SS with less than 20% 2nd rater or adequate inter-rater reliability k=0.61-0.80	SS and other validated observational methods. 20% + rated by second coder. Good inter-rater reliability reported $k \geq 0.81$.
Sample	Recruitment unspecified or sampling methods are unclear.	Single restricted or non-random sample e.g., a specialist clinic or previous research study. Single regional sample e.g., a regional parent support group.	Multiple restricted or non-random samples e.g., multi-region specialist clinics, multiple schools. National non-random sampling e.g., national parent support groups.	Random Sample
Replicability	Methodology is unclear, or insufficient data provided to replicate	Likely replicable, sufficient data provided on population and sample size.	N/A	Methodology replicable Characteristics of populations are clearly described.
Statistical approach and Reporting	Inappropriate or unclear what analysis was used, or unclear reporting of results.	Partial reporting. Not all descriptive/ measures are reported.	N/A	Appropriate analysis using statistical tests and reported. For intervention studies pre-intervention or control data must be reported.

Note. MM = mind-mindedness, SS = Strange Situation

Data Extraction

A customised data extraction questionnaire was developed to include the following information: study descriptors (title/authors, publication year, country, study design); sample characteristics (sample size, gender, gestational age, age at assessment, clinical population, attrition rate, ethnicity, social economic status); methodology (design, measures used); the mean and standard deviations, and correlations of the mind-mindedness and attachment measures. This information has been summarised in Table 3.

All data were extracted by two researchers independently. Cohen's Kappa, *k* (Cohen, 1960) was used to calculate inter-rater reliability. The percentage agreement for data extracted was 96.5%, and the Kappa was calculated as $k = 0.89$, indicating an excellent level of inter-rater agreement (Cohen, 1960). Any differences in data extracted were discussed and papers reviewed, prior to agreeing on what data to include.

Data Analysis

Data were analysed using RStudio (version4.2.1). The majority of studies included in the analysis focused on the secure-insecure attachment continuum. Therefore, this was the focus in the current study and not the organized-disorganized continuum (Main & Solomon, 1986). Of the studies using the observational assessment of mind-mindedness, all reported on the effects of the appropriate index, and some reported on the non-attuned index (K = 14). The two study designs identified were group level data and correlations, between mind-mindedness and attachment. Therefore, four meta-analyses were conducted.

Meta-analysis 1 examined group-level data for appropriate mind-mindedness split by attachment security. Meta-analysis 2 examined non-attuned mind-mindedness split by

attachment security. Standardised mean difference (SMD) was used to calculate the size of the effect for each study in these analyses and was represented as Cohen's D (Cohen, 1988). Data included in these analyses involved all biological mothers and mind-mindedness was assessed using an observational method. Similarly, attachment was assessed using an observational method in all but one study. With limited variation in the variables of the studies included, no subgroup analysis was able to be conducted.

Meta-analyses 3 and 4 examined the correlational data between continuous measures of attachment security and appropriate mind-mindedness and non-attuned mind-mindedness, respectively. Data included multiple variables which were explored using subgroup analyses.

The results section will summarise the following analyses. For each meta-analysis, the effects of random and fixed effects models were tested using the Restricted Maximum Likelihood Estimator (REML). This model was indicated as an appropriate method for the calculation of the variation of the true effect of each analysis, as this estimator has been shown to be more robust to deviations from normality (Banks, Mao, & Walters, 1985). A random effects model was preferred, due to the variance between the studies; this was calculated using the generic inverse variance method.

An omnibus test was run to determine any difference in the parameters specified. If heterogeneity was high (above 75%) then the impact of disproportionately influential studies was assessed using a "leave-one-out" analysis and Baujat plots examined. In this analysis, the random effects model was calculated with each of the primary studies removed in turn. The change in weighted average effect size (i.e., influence) and the change in heterogeneity (i.e., discrepancy) were then recorded. In the event of identifying papers that are notably discrepant and influential, these studies will be reviewed. If the study is noted as having a high risk of bias overall, or differs substantially from other papers in the field, the paper will be noted as

an outlier and analysis recommenced with the paper removed. If neither of these is the case, the paper will be reviewed.

The quality effects model was calculated using the mean scores of the risk of bias ratings reported in Table 4. This score considers the position of each study's overall design within the study design hierarchy and the ratings of risk of bias (Table 4). The quality effects model can be interpreted as the meta-analytic synthesise that would have been obtained, had all the studies been of the same methodological quality as the best study in the review. To assess which area of risk of bias was exerting an effect on the meta-analytic conclusions, a series of meta regression analyses were conducted on each of the five types of methodological bias (Table 2 & 4).

The impact of publication bias and small study biases were identified via a funnel plot. Publication bias is caused by the tendency for statistically significant results to be published and the reticence to publish papers with non-significant results. Small study bias is the tendency for studies with smaller sample sizes to show greater variability in their measurement of attachment. This funnel plot charts the magnitude of the study's standardised mean difference (i.e., the importance of the study in the synthesis) against the estimation of the studies' deviation from the meta-analytic average (i.e. the discrepancy of the study within the literature). If there is evidence of publication bias, the effect of this is simulated using a trim and fill procedure (Duval & Tweedle, 2000). The trim and fill procedure builds on the assumption that publication bias would lead to an asymmetrical funnel plot. The trim and fill procedure iteratively removes the most extreme small studies from the side of the funnel plot associated with positive effects, re-computing the effect size at each iteration, until the funnel plot is symmetric about the (corrected) effect size. While this trimming yields the adjusted effect size, it also reduces the variance of the effects, resulting in biased and narrow confidence intervals. Therefore, the original studies are returned into the analysis and the

procedure imputes a mirror image for each study, on the side of the funnel plot associated with negative effects. Furthermore, a calculation of a failsafe number (Rosenthal, 1979) was used to calculate the number of non-significant results which would need to be included in the meta-analysis, for the overall effect to be non-significant ($p > .05$).

Results

The search and selection process are shown in Figure 1. The search returned 1042 papers; after duplicates were removed, 764 papers remained. A total of 733 papers were screened out for not meeting inclusion criteria (Table 1).

Of the 31 papers included, nine reported group mean differences and 16 reported correlations between mind-mindedness and attachment, with a total of 3676 participants. Seven studies were only included in the narrative review due to methodological differences. Descriptive statistics of all studies included in the meta-analyses are included in Table 3. Studies primarily included biological parents; 26 studies included mothers and seven studies included fathers. Four studies involved non-biological caregivers and two studies explored mind-mindedness with undergraduate students. All participants varied in level of education and socioeconomic status. Country of origin varied across the literature, with a third of the studies originating in the UK, and a third originating from America and Canada. All but seven studies included a free play measure of mind-mindedness. All reported on the effects of the appropriate index, and some reported on the non-attuned index (K = 14). Observational methods were the predominant assessment method of attachment (Strange Situation or AQS), with five studies using the Adult Attachment Interview (AAI; George, Kaplan & Main, 1985). Five studies used antenatal attachment measures. When papers reported data on multiple attachment or mind-mindedness measures, those with the highest reliability statistics as presented by the authors, were used.

Overall Methodological Bias

Methodological bias was mixed across the studies. All studies conducted appropriate analyses, however some only reported partial data, reducing their score on this factor. Table 4 illustrates the ratings for each area of bias by study, with an overall quality index. The higher the overall score, the lower the risk of bias.

Table 3.

Description of Studies Included in Review

Paper label	Country	N	Population	MM Measure	Age at MM testing	Attachment Measure	Age at attachment testing	Means	Correlations	Narrative Review
Arnott & Meins 2008	UK	28 (25 triads & 3 mothers) 21 (17 triads & 4 mothers)	Mothers & fathers	Antenatal Interview & Free play	Antenatal & 6 months	MAAS & PAAS.	Antenatal	X	Appropriate & Non-attuned	
Arnott & Meins 2007	UK	28 (25 triads & 3 mothers)	Mothers & fathers	Free play	6 months	AAI & SS	Antenatal & 12 months	Appropriate & Non-attuned	X	X
Bernier & Dozier 2003	America	64	Non-biological caregiver	Interview	6-30 months	AAI & SS	3-24 months	X	Appropriate	Regression
Bigelow et al 2018	Canada	87	Mothers	Free play	4 months	SS	12 months	Appropriate & Non-attuned	Appropriate & Non-attuned	Regression
Colonnesi et al 2017	Netherlands	35	Non-biological caregiver	Free play	33-38 months	AQS	33-38 months	X	Appropriate	Regression
Demers et al 2010a	Canada	106	Adult & Adolescent mothers	Interview	18 months	AAI	6 months	X	Appropriate	Regression
Demers et al 2010b	Canada	104	Adult & Adolescent mothers	Free play	18 months	SS	18 months	X	Appropriate	X
Dollberg 2022	Israel	68	Mothers	Free Play	3 months	ECR	Antenatal	X	X	Avoidance / Anxiety attachment

Gagne, Lemlin & Tarabulsy 2021	Canada	110	Mothers	Free play	8 months	SS	16 months	Appropriate & Non-attuned	X	X
Hill & McMahon 2016	Australia	103	Mothers	Interview	2.1-5.1 years	ASQ	2.1-5.1 years	X	X	Avoidance / Anxiety attachment
Ierardi et al 2022	Italy	98	Adolescent mothers	Free play	3 months	AAI	3 months	X	Appropriate & Non-attuned	X
Laranjo, Bernier & Meins 2008	Canada	50	Mothers	Free play	12-13 months	AQS	15-16 months	X	Appropriate	X
Lundy 2003	America	24	Mothers & fathers	Free play	6 months	AQS	13 months	X	Appropriate	X
McMahon et al 2016	Australia	164	Mothers	Free play & Interview	7 & 19 months	MFAS	Antenatal	X	Appropriate & Non-attuned	X
McNamara et al 2022	Australia	43	Mothers	Interview	Antenatal	MFAS	Antenatal	X	Appropriate	Regression
Meins, Bureau & Fernyhough 2018	UK	206	Mothers	Free Play	8 months	SS	15, 44 & 51 months	Appropriate & Non-attuned	X	Regression
Meins et al 2001	UK	71	Mothers	Free Play	6 months	SS	12 months	Appropriate	X	Regression
Meins et al 2008	UK	270	Undergraduate students	Interview	18-35 years	Relationship Questionnaire	18-35 years	X	X	Avoidance / Anxiety attachment
Meins et al 2012	UK	206	Mothers	Free Play	8 months	SS	15 months	Appropriate & Non-attuned	X	Organised/ Disorganised attachment
Meins et al 2002	UK	75	Mothers	Free Play	6 months	SS	12 months	X	Appropriate & Non-attuned	X
Miller et al 2019	America	102	Mothers & fathers	Free Play	7 months	AQS	2 years	X	Appropriate & Non-attuned	
Planalp et al 2019	America	241	Mothers & Fathers	Free Play	3, 5 & 7 months	SS	12 & 14 months	X	X	Regression

Reese et al 2019	UK	206	Mothers	Free Play	8 months	SS	15 months	X	Appropriate	X
Regueiro et al 2022	Canada	108	Mothers & fathers	Free Play	18 months	AQS	15 & 24 months	X	X	Paternal MM & maternal Attachment
Riva Crugnola, Ierardi & Canevini 2018	Italy	85	Adult & Adolescent mothers	Free play	3 months	AAI	3 months	X	Appropriate & Non-attuned	X
Riva Crugnola et al 2021	Italy	44	Adult & Adolescent mothers	Free play	3 months	AAI	3 months	Appropriate & Non-attuned	X	X
Shai & Meins 2018	UK	206	Mothers	Free Play	8 months	SS	15 months	Appropriate & Non-attuned	X	Regression
Spruit et al 2021	Netherlands	446 (182 mothers & 196 fathers)	Biological & non biological caregivers	Describe your child interview	2-5 years	Relationship Questionnaire & AQS	2-5 years	X	Appropriate	
Szpak & Bialecka-Pikul 2015	Poland	110	Undergraduate students	Describe a close friend	M=22.22	Psychosis attachment Measure	M=22.22	X	X	Avoidance /Anxiety attachment style
Tarabeh et al 2018	Israel	85	Mothers	Free Play	12-18 months	SS	12-18 months	Appropriate & Non-attuned	X	
Zeegers et al 2019	Netherlands	53	Non biological caregivers	Describe your child	3-11 years	AISI	3-11 years	X	X	Avoidance /Anxiety attachment

Note. AAI = Adult Attachment Interview, AISI = Attachment Insecurity Screening Inventory, AQS = Attachment Q-Sort, ASQ = Attachment Style Questionnaire, ECR = Experience of Close Relationships Questionnaire, MAAS =Maternal Antenatal Attachment Scale, PASS = Paternal Antenatal Attachment Scale, MFAS =Maternal Fetal Attachment Scale, SS = Strange Situation.

Table 4.

Quality Framework Ratings

Study label	MM Measure	Attachment Measure	Sample	Replicability	Statistical approach & Reporting	Overall Quality Index
Arnott & Meins 2008	3	2	2	3	1	**2.2**
Arnott & Meins 2007	2	3	2	3	3	**2.6**
Bernier & Dozier 2003	3	2	1	1	3	**2**
Bigelow et al 2018	3	2	1	3	3	**2.4**
Colonnesi et al 2017	1	3	2	1	3	**2**
Demers et al 2010a	3	2	2	3	3	**2.6**
Demers et al 2010b	1	3	2	3	3	**2.4**
Dollberg 2022	3	2	2	3	3	**2.6**
Gagne, Lemlin & Tarabulsy 2021	3	3	1	3	3	**2.6**
Hill & McMahon 2016	3	2	2	3	3	**2.6**
Ierardi et al 2022	3	2	1	3	3	**2.4**
Laranjo, Bernier & Meins 2008	1	3	1	1	1	**1.4**
Lundy 2003	2	2	2	3	1	**2**
McMahon et al 2016	3	2	2	3	3	**2.6**
McNamara et al 2022	1	2	1	1	3	**1.6**
Meins, Bureau & Fernyhough 2018	2	2	2	3	3	**2.4**
Meins et al 2001	2	3	2	3	3	**2.6**
Meins et al 2008	3	2	1	1	3	**2**
Meins et al 2012	2	3	2	3	3	**2.6**
Meins et al 2002	2	3	2	3	3	**2.6**
Miller et al 2019	1	3	2	3	3	**2.4**
Planalp et al 2019	1	3	2	3	2	**2.2**
Reese et al 2019	2	3	2	3	1	**2.2**
Reguerio et al 2022	2	2	2	3	1	**2**
Riva Crugnola, Ierardi & Canevini 2018	3	2	1	3	3	**2.4**
Riva Crugnola et al 2021	3	2	2	3	2	**2.4**
Shai & Meins 2018	2	3	2	3	3	**2.6**
Spruit et al 2021	2	2	2	3	3	**2.4**
Szpak & Bialecka-Pikul	3	2	0	3	2	**2**
Tarabeh et al 2018	1	2	1	1	3	**1.6**
Zeegers et al 2019	3	2	0	1	1	**1.4**

Note. MM = Mind-mindedness
Overall Quality Index = Mean score of all five quality criteria.

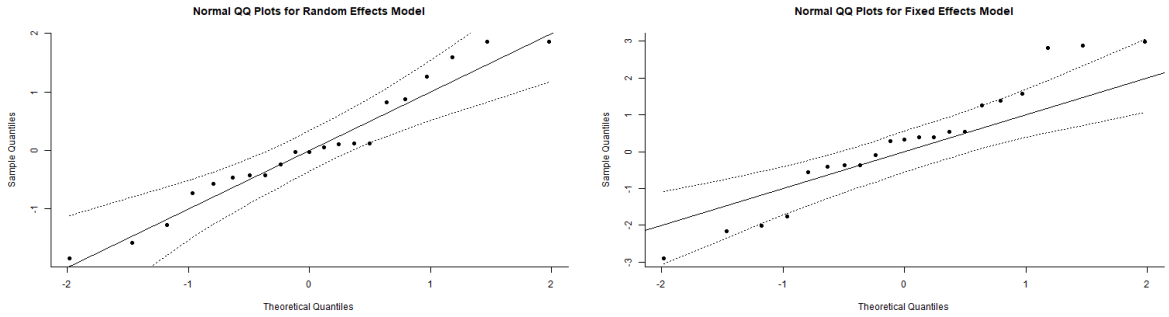
Meta-Analysis 1: Standardised mean difference between secure and insecure attachment style for appropriate mind-mindedness.

Selection of the Meta-Analytic Model

The between studies variance (tau^2) was calculated using the REML, with the distribution of primary study effects shown in Figure 2. There is evidence of non-linearity in the distribution of standardised mean differences in the fixed effects model, which is largely absent from the random effects model. Therefore, this indicates that the use of the random effects model in which between groups variation is estimated using the REML, is an appropriate method for the calculation of these data.

Figure 2.

QQ Plot of the Distribution of Standardised Mean Differences between Secure and Insecure Attachment Style.



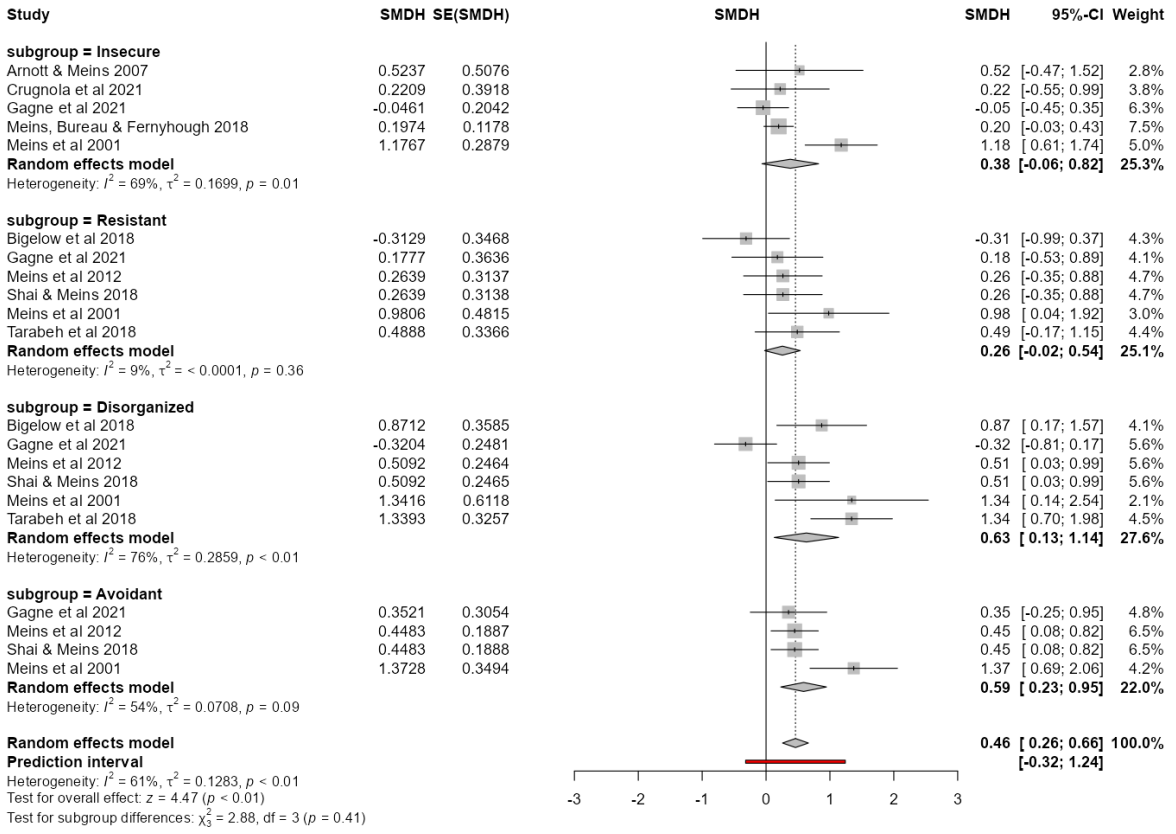
The Omnibus Test

There were 21 standardised mean differences reported in nine studies with a total of 1102 participants; these are displayed according to insecure attachment style (Figure 3). Descriptions of study effects are reported in Appendix A. Participants were involved in testing within the first 18 months of the child's life, with only two data points reported

outside of this. All but one study used the Strange Situation, and all studies used an observational assessment of mind-mindedness. All participants involved in the studies were biological mothers of the children included.

Figure 3.

Forest Plot of the Standardised Mean Difference between Secure and Insecure Attachment Styles.



Note. A positive value indicates higher values for the secure attachment style, and a negative value indicates higher values of insecure attachment style.

The Random Effects Model returned a significant difference between Secure and Insecure attachment styles overall, SMD = 0.46 (95%CI: 0.26; 0.66). A positive effect here corresponds to more appropriate mind-mindedness in the securely attached group. The

overall model returned acceptable levels of heterogeneity(I^2 = 61%, tau^2 = 0.13, Q = 50.79, p < 0.01). This suggests an acceptable level of variation in the primary studies, with this body of studies reporting a coherent and consistent effect size. There was no evidence that the nature of the insecure attachment style affected this estimate, X^2 = 2.88, p = 0.41. When examined independently, there was evidence for a difference between Secure and Avoidant, SMD = 0.59 (95%CI: 0.23; 0.95) and Secure and Disorganised, SMD = 0.63 (95%CI 0.13; 1.14) subtypes. Marginally non-significant estimates were returned for comparisons between Secure and Resistant, SMD = 0.26 (95%CI -0.02 to 0.54) and Secure and unspecified Insecure SMD = 0.38 (95%CI -0.06 to 0.82) subgroups. As the overall heterogeneity was of an acceptable level (below 75%) the impact of influential studies using the "leave one out analysis" is included in Appendix B, for additional information only.

The Effect of Risk of Bias in the Primary Studies

The quality effect model reported a synthesis of SMD = 0.45 (95% CI 0.24 to 0.65). The quality effects model evidences an approximately 3.4% decrease relative to the uncorrected random effects estimate. This is a negligible change in the weighted average of these studies.

A meta regression analysis identified a significant effect for the risk of bias in the measure of mind-mindedness, with a unit decrease in the risk rating being associated with a reduction in the overall effect (β = -0.44; Table 5).

Table 5

Meta-regression of the Impact of Quality Rating Fields on the Standard Mean Difference between Appropriate Mind-mindedness and Attachment

					Confidence Interval	
	Estimate	SE	Z	P	Lower	Upper
MM Measure	***-0.44***	***0.14***	***-3.07***	***0.002***	***-0.72***	***-0.16***
Attachment measure	0.02	0.24	0.08	0.94	-0.44	0.48
Sample	0.29	0.20	1.36	0.17	-0.12	0.69
Replicability	-0.25	0.17	-1.46	0.14	-0.59	0.09
Statistical approach and reporting	0.25	0.55	0.46	0.65	-0.82	1.33

Note. MM= mind-mindedness

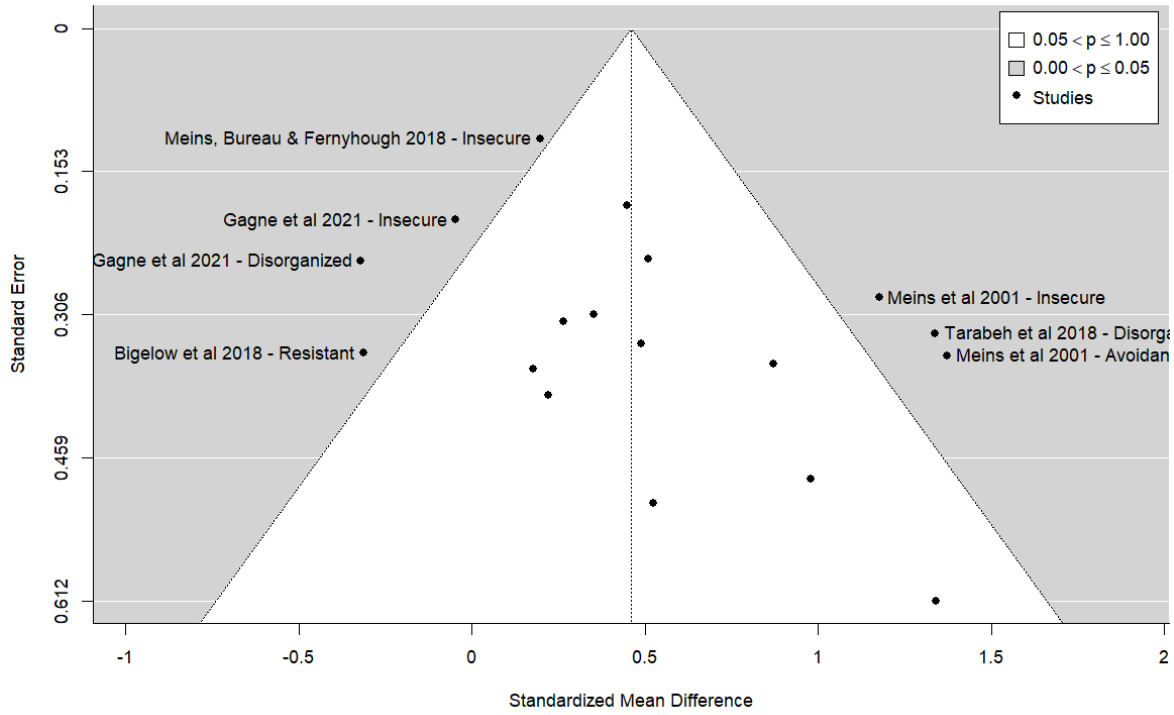
The Impact of Publication and Small Study Biases

If there is an absence of publication bias, the effects from the studies with small sample sizes which show greater variability, will scatter more widely at the bottom of the plot. This compares with studies of larger samples at the top which will lie closer to the overall meta-analytic effect, creating a symmetrical funnel shape. If there is an absence of studies in the area of the plot associated with small sample sizes and non-significant results, then it is likely there is some publication bias, leading to an overestimation of the true effect.

The funnel plot (Egger et al., 1997) of standardised mean difference of mind-mindedness between secure and insecure attachment is presented in Figure 4. There is some evidence of publication bias in the distribution of standardised mean differences, however, this does not achieve statistical significance ($t(19) = 1.89$, $p = 0.07$).

Figure 4.

Egger et al (1997) Funnel plot of the Standard Mean Difference between Secure and Insecure Attachment Styles and Appropriate Mind-Mindedness

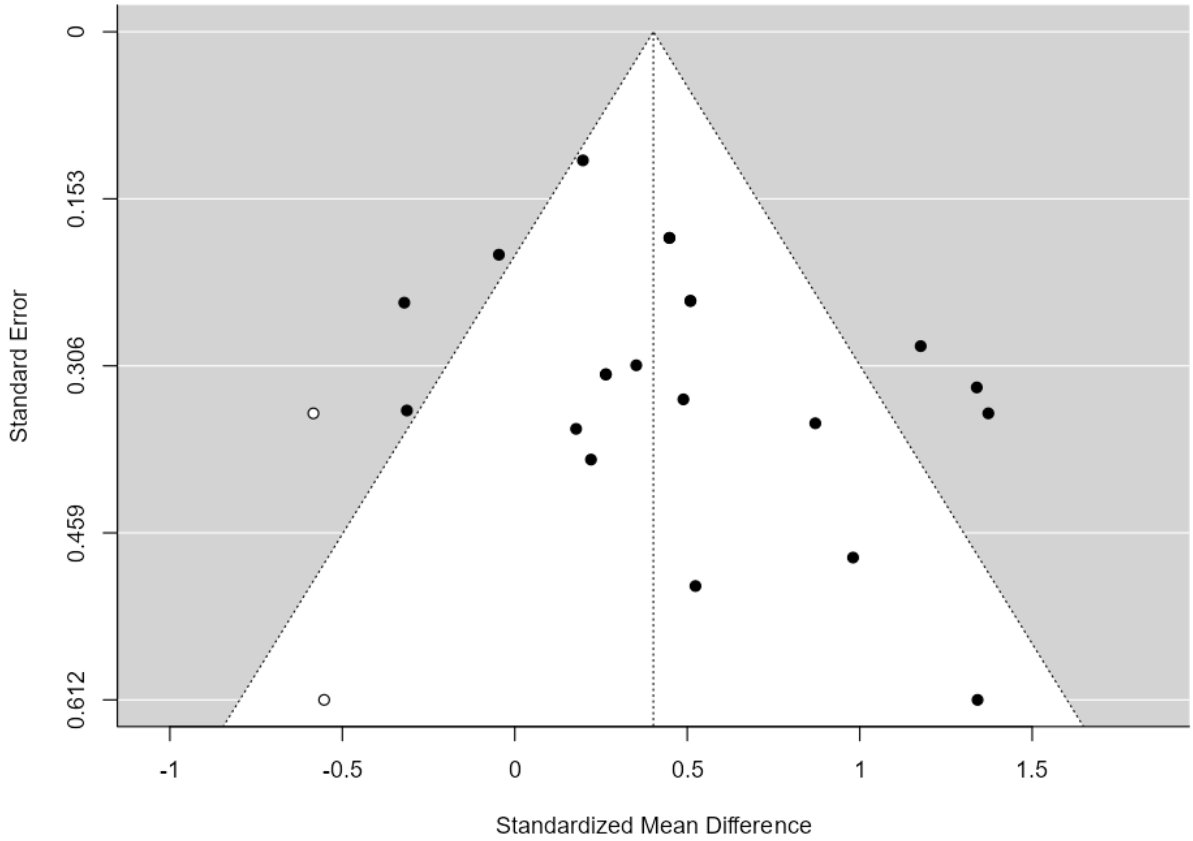


Due to the trend towards significance, the effect of the publication bias is simulated using a trim and fill procedure (Duval & Tweedle, 2000) (Figure 5). In Figure 5, the observed studies are shown as dark circles. The omnibus estimate of the effect size is 0.46 (95% CI 0.26, 0.66). The imputed studies are shown as empty circles, and the imputed estimate is 0.40 (95% CI 0.19, 0.61). The adjusted point estimate represents a 2.79% decrease relative to the original omnibus analysis and would not change the overall conclusion of this analysis.

The calculation of a failsafe number (Rosenthal, 1979) suggests that 389 studies would be required to reduce the observed SMD = 0.46 to non-significance, suggesting that the observed effect is robust to studies missing, due to publication bias.

Figure 5.

Funnel Plot of the Standard Mean Difference between Secure and Insecure Attachment Styles with Appropriate Mind-Mindedness using the trim on fill procedure (Duval & Tweedle (2000).



Note. The 95% confidence interval of the expected distribution of standard mean difference is shown as an inverted "funnel". Effect size marked with a white dot indicates imputed studies using the trim on fill procedure of Duval & Tweedle (2000).

Meta-Analysis 2: Standardised mean difference between secure and insecure attachment style for non-attuned mind-mindedness.

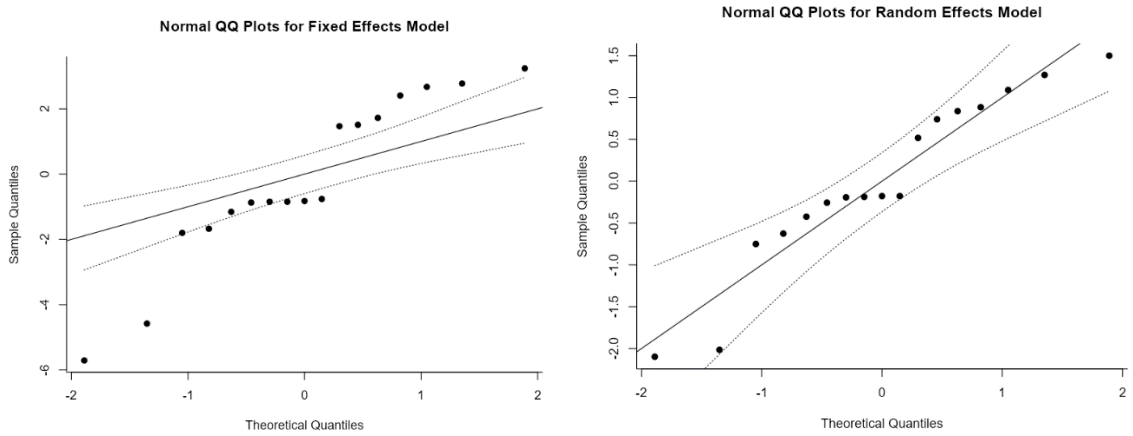
Selection of the Meta-Analytic Model

The distribution of primary study effects is shown in Figure 6, demonstrating some evidence of non-normality in the distribution of standardised mean differences in the fixed effects model, which is absent from the random effects model. This indicates that the use of

the REML is an appropriate method for the calculation of the random effects model of the between groups data.

Figure 6.

QQ Plot of the Distribution of Standardised Mean Differences between Secure and Insecure Attachment Style.



The Omnibus Test

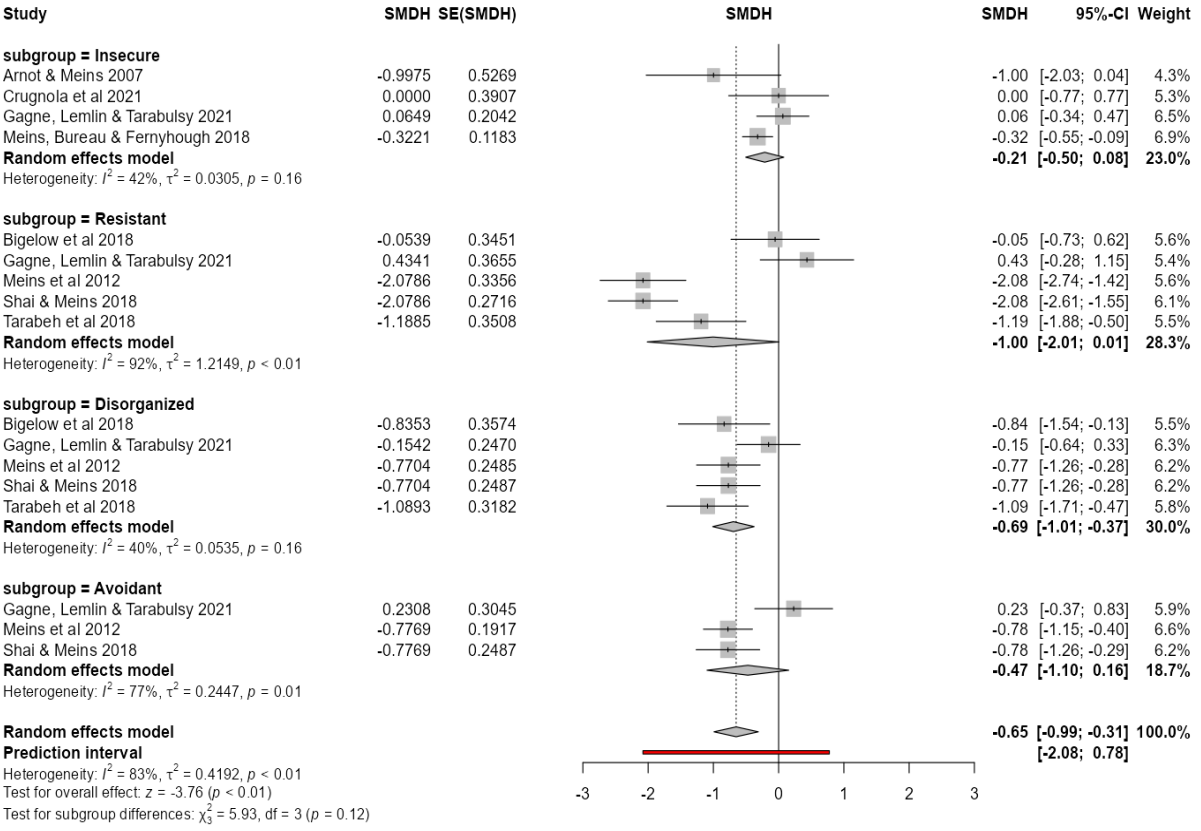
The descriptive statistics of the primary studies are reported in Appendix C. There were 17 standardised mean differences reported in nine studies in a total of 1008 participants; these are displayed according to insecure attachment style (Figure 6). All participants and variables are the same as in meta-analysis 1.

The random effects model returned a significant difference between Secure and Insecure attachment styles overall, SMD = -0.65 (95%CI -0.99 to -0.31). This is consistent with evidence that the securely attached group showed less non-attuned mind-mindedness. There was no evidence that the nature of the insecure attachment style affected this estimate, X^2 = 5.93, p = 0.12. With respect to the unspecified insecure, resistant, and avoidant attachment style, the random effects model returned marginally non-significant weighted average mean

difference of SMD = -0.21 (95%CI -0.50 to 0.08), SMD = -1.00 (95%CI -2.01 to 0.01) and SMD = -0.47 (95%CI -1.10 to 0.16), respectively. The disorganised attachment style evidenced a statistically significant weighted average mean difference of SMD = -0.69 (95%CI -1.01 to -0.37).

Figure 7.

Forest Plot of the Standardised Mean Difference between Secure and Insecure Attachment Styles for Non-Attuned Mind-Mindedness.



Note. A positive value indicates higher values for the secure attachment style, and a negative value indicates higher values of insecure attachment style.

The overall model returned unacceptably high levels of heterogeneity (tau² = 0.42, I^2 = 83%; Q = 96.91, p < 0.01), suggesting that the estimates of standardised mean difference between secure and insecure attachment styles within the primary studies may be biased, by

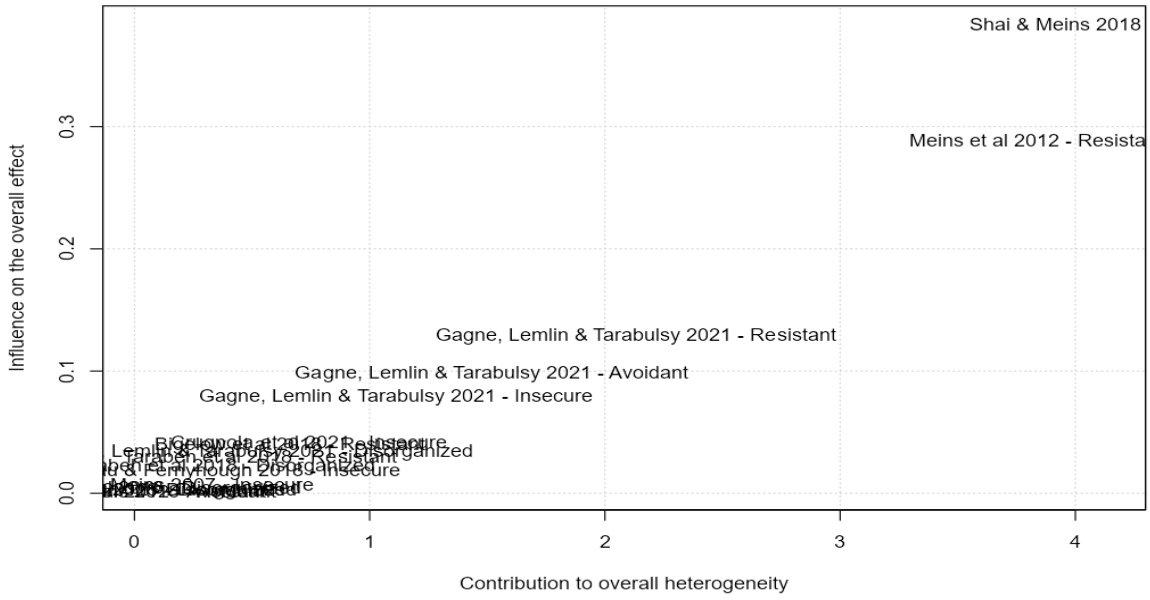
the presence of uncontrolled or confounding factors. Therefore, the focus of the subsequent analyses was on the identification of the sources of heterogeneity between the estimates of the difference between secure and insecure attachment style.

The Impact of Influential Primary Studies

The result of this "leave-one-out" analysis is presented on the Baujat plot (Baujat et al., 2002) in Figure 7. The Baujat plot indicates that Meins et al. (2012) and Shai and Meins (2018) were both influential on the overall meta-analytic synthesis and were most discrepant from the average reported effect in the majority of the literature. The two studies were reviewed as they both scored high for the risk of bias assessment and were broadly consistent with methodological approaches in the field, these studies were retained for subsequent analysis.

Figure 8.

Baujat Diagnostic Plot of Sources of Heterogeneity.



Note. The vertical axis reports the influence of the study on the overall effect and the horizontal axis reports the discrepancy of the study with the rest of the literature.

The Effect of Risk of Bias in the Primary Studies

The quality effect model reported a synthesis of SMD = -0.64 (95% CI -0.98 to -0.29). The quality effects model evidenced an approximately 1.54% decrease in magnitude relative to the uncorrected random effects estimate, suggesting that studies with less risk of bias tend to report marginally smaller effect sizes.

A meta regression analysis identified a significant effect for the risk of bias in the measure of mind-mindedness and sample, with an increase in the risk rating being associated with an increase in the overall effect (Table 6). Studies with high quality scores for MM measure have a bigger effect (i.e., less negative, so actually show less difference), high quality scores for sample measure have a smaller effect (i.e., more negative, so actually show more difference). It is possible that such risk of bias could contribute to heterogeneity.

Table 6.

Meta-regression of the Impact of Quality Rating Fields on the Standard Mean Difference between Non-Attuned Mind-Mindedness and Attachment

					Confidence Interval	
	Estimate	SE	Z	P	Lower	Upper
MM Measure	***0.70***	***0.21***	***3.36***	***<.001***	***0.29***	***1.10***
Attachment measure	-0.11	0.38	-0.30	0.77	-0.85	0.62
Sample	***-0.63***	***0.32***	***-1.97***	***0.05***	***-1.25***	***0.00***
Replicability	0.27	0.27	1.00	0.32	-0.26	0.81
Statistical approach and reporting	-0.69	0.78	-0.88	0.38	-2.22	0.85

Note. MM = Mind-Mindedness

The Impact of Publication and Small Study Biases

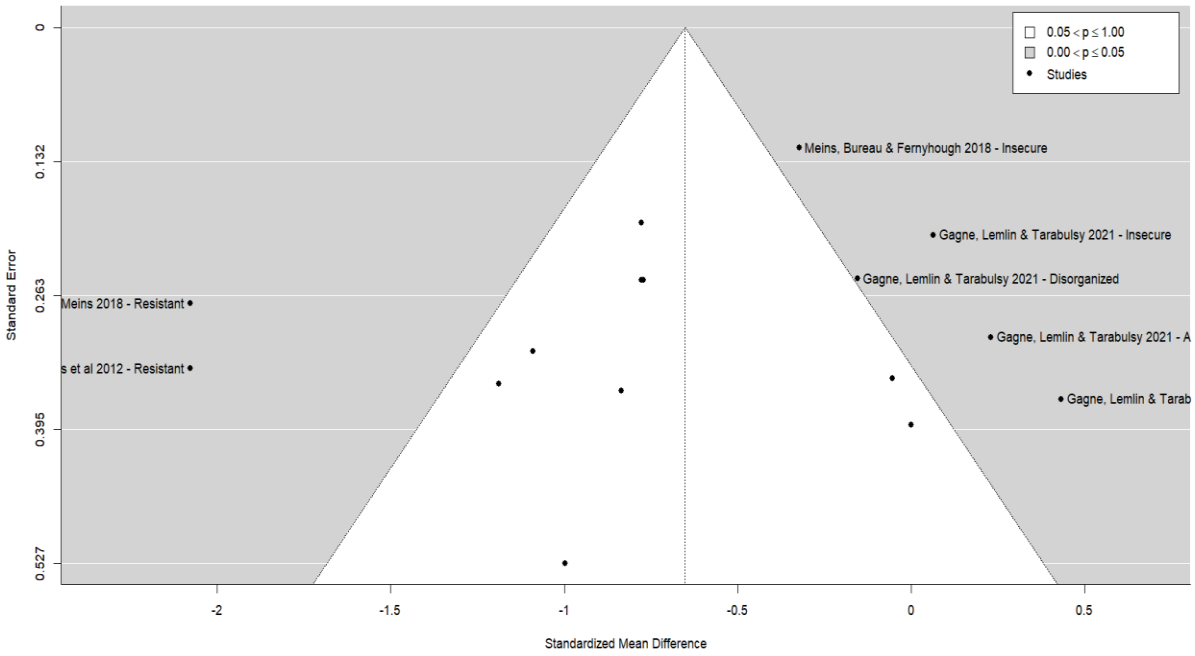
As can be seen from Figure 8, there is no evidence of publication bias in the distribution of standardised mean differences. This conclusion is further strengthened by the observation that

Eggar' s (1997) test of funnel plot asymmetry was not statistically significant (t(15) = -0.96, *p* = 0.35).

The calculation of a failsafe number (Rosenthal, 1979) suggests that 560 studies would be required to reduce the observed SMD = -0.65 to non-significance, suggesting that the observed effect is robust to studies missing, due to publication bias.

Figure 9.

Funnel Plot of the Difference between Secure and Insecure Attachment Style in the Non-Attuned Mind-mindedness.



Note. The 95% confidence interval of the expected distribution of standard mean difference is shown as an inverted "funnel".

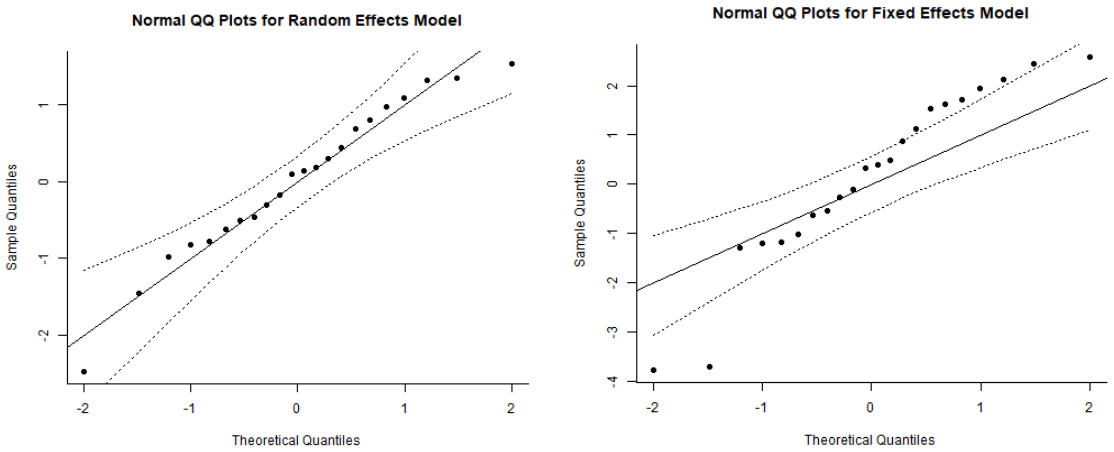
Meta-analysis 3: Correlation between appropriate mind-mindedness and attachment

Selection of the Meta-Analytic Model

The distribution of primary study effects is shown in Figure 9. There is clear evidence of non-linearity in the distribution of correlations when using the fixed effect model, which is absent when the synthesis is calculated, using the random effects model. This indicates that the use of the REML is an appropriate method for the calculation of the variation of the true effect.

Figure 10.

QQ Plot of the Distribution of Correlations Within the Included Studies.



The Omnibus Test

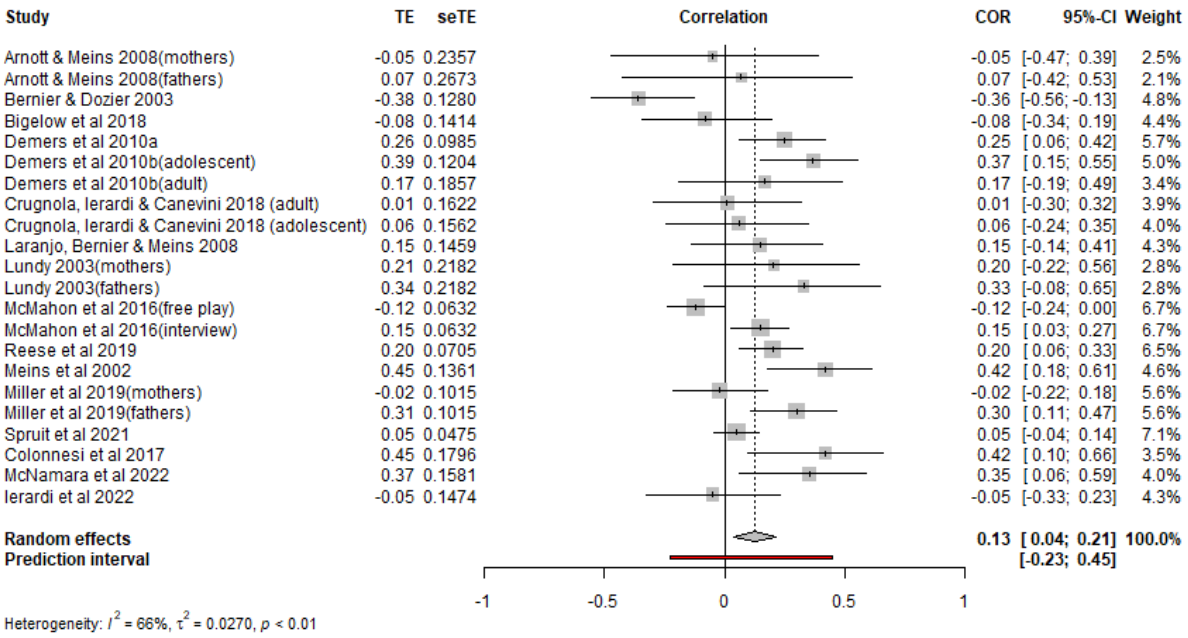
The descriptive statistics of the primary studies are reported in Appendix D. Sixteen studies reported 22 effects, in a total of 1389 participants (Table 10). All participants involved in the studies were biological mothers of the children included, except in three studies that included non-biological caregivers. Children were below 18 months of age, except in three studies. Half of the studies used an observational assessment of attachment

(Strange Situation or AQS), and half used various questionnaires or interview methods. All but five studies used an observational assessment of mind-mindedness.

The random effects model suggested a small but statistically reliable weighted average Pearson correlation of $r = 0.13$ ($z = 2.77$, $p = 0.0056$) and a 95% confidence interval of between 0.04 to 0.21. This is consistent with higher appropriate mind-mindedness scores being associated with higher attachment scores.

Figure 11.

Forest Plot of Correlation between Appropriate Mind-mindedness and Attachment.



Note. A positive value indicates higher values for the secure attachment style, and a negative value indicates higher values of insecure attachment style.

The level of heterogeneity in the primary studies was acceptable (Higgin's $I^2 = 66\%$; tau^2 = 0.03, $Q = 62.15$, $p < 0.01$). This suggested an acceptable level of variation in the primary studies, with this body of studies reporting a coherent and consistent effect size. Therefore, the impact of influential studies using the "leave one out analysis", is included in Appendix E for additional information only.

The Effect of Risk of Bias in the Primary Studies

The quality effects model reported a synthesis of $r = 0.12$ (95% CI 0.03 to 0.21). The quality effects model evidenced less than 1% decrease relative to the uncorrected random effects estimate. Accordingly, when the synthesis included information about the methodological quality of the studies, there was no substantial and meaningful change in the weighted average of these studies.

A meta regression analysis identified a significant effect for the risk of bias in the measure of mind-mindedness and sample, with an increase in the risk rating being associated with an increase in the overall effect (Table 7).

Table 7.

Meta-regression of the Impact of Quality Rating Fields on the Correlation between Appropriate Mind-mindedness and Attachment

					Confidence Interval	
	Estimate	SE	Z	P	Lower	Upper
MM Measure	***-0.13***	***0.05***	***-2.81***	***0.01***	***-0.22***	***-0.04***
Attachment measure	0.17	0.09	1.86	0.06	-0.01	0.34
Sample	***0.21***	***0.08***	***2.60***	***0.01***	***0.05***	***0.37***
Replicability	0.01	0.06	0.12	0.91	-0.12	0.13
Statistical approach and reporting	-0.03	0.06	-0.45	0.65	-0.14	0.09

Note. MM = Mind-Mindedness

Subgroup analysis 1: The Effect of the Measure Used to Assess Attachment.

The effect of the attachment measure was assessed by calculating a subgroup plot (Appendix F) for studies that had used the Strange Situation, AAI and the AQS. Other measures of attachment were not included in this analysis, due to the small number of studies for each of the methods. There was no statistically significant difference ($X^2 = 0.43$, $p = 0.81$) between the weighted average correlations for each of these three methods of measuring attachment.

Subgroup analysis 2: The Effect of the Measure Used to Assess Mind-Mindedness.

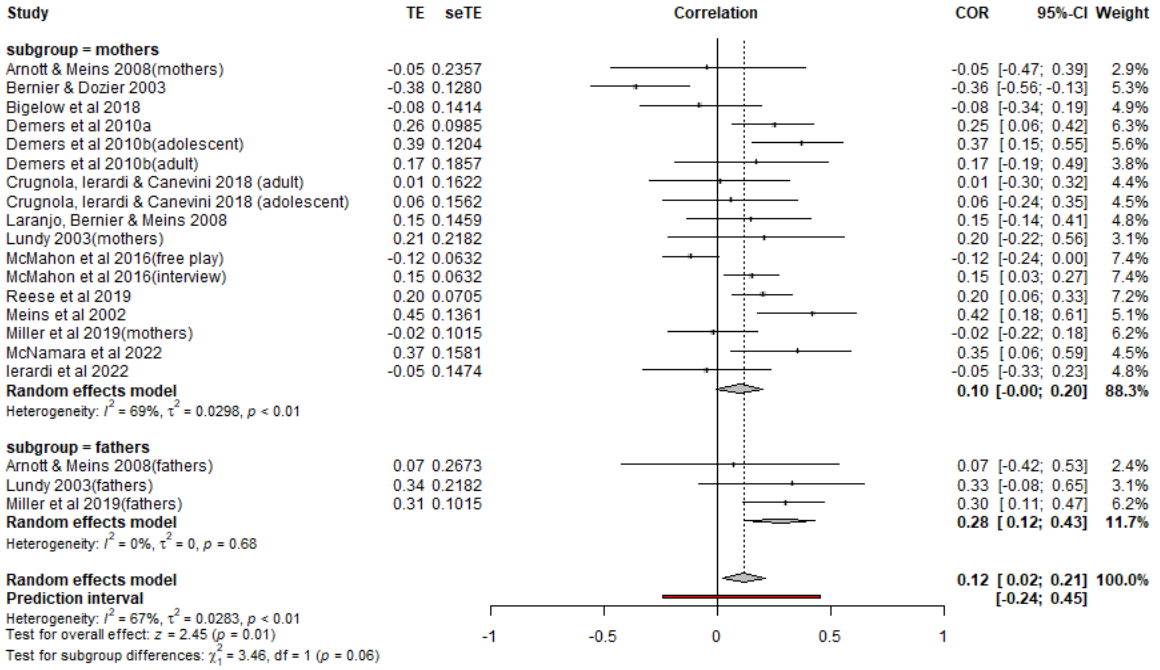
The effect of the measure of mind-mindedness was assessed by calculating a subgroup plot (Appendix G). There was no statistically significant difference ($X^2 = 0.17$, $p = 0.68$) between the weighted average correlations for each of the methods of measuring mind mindedness. It should be noted that there were only five studies that reported on the representational (interview) measure; four other studies were not included due to using an alternative study design. Therefore, the estimate of the relationship between representational mind mindedness and attachment may not be robust and may change with the publication of future studies.

Subgroup analysis 3: Differences in Studies that Measured the Relationship between Appropriate Mind-Mindedness and Attachment for Mothers and Fathers.

The effects of the relationship between appropriate mind-mindedness and attachment for mothers and fathers was assessed by calculating a subgroup plot (see Figure 12). There was trend toward a significant difference ($X^2 = 3.46$, $p = 0.06$) between the weighted average correlations for maternal and paternal relationship, with fathers showing larger effects. It should be noted that there are only three studies which report parental attachment in fathers and therefore the estimate of the relationship between paternal attachment and mind mindedness may not be robust and may change with the publication of future studies.

Figure 12.

Sub-Group Plot of the Differences in the Relationship between Appropriate Mind-Mindedness and Attachment for Mothers and Fathers.



Note. A positive value indicates higher values for the secure attachment style, and a negative value indicates higher values of insecure attachment style.

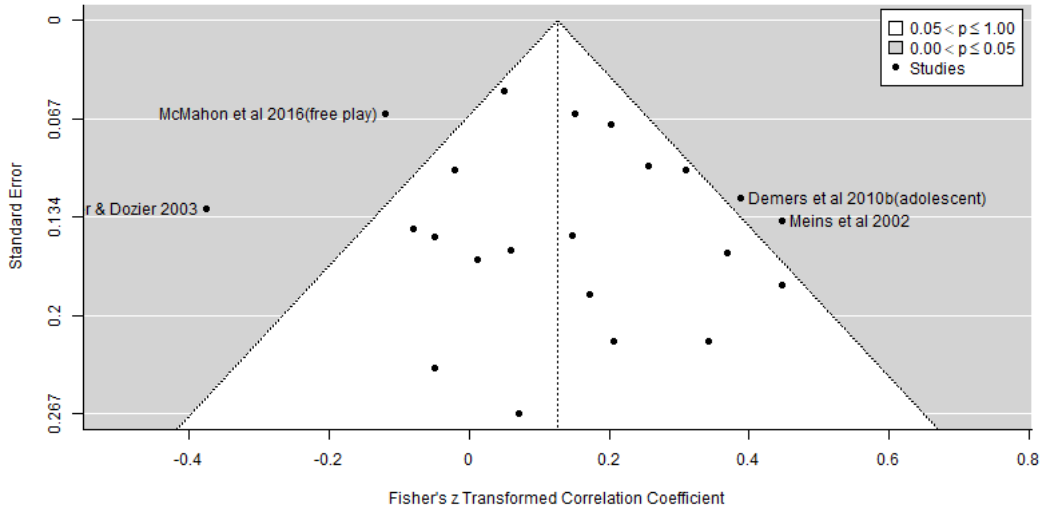
The Impact of Publication and Small Study Biases

As can be seen from Figure 13, there is no clear evidence of publication bias in the distribution of the correlation between attachment and mind mindedness. This conclusion is further strengthened by the observation that Eggar et al. (1997) test of funnel plot asymmetry was not statistically significant (t(20) = 0.97, p = 0.34).

The calculation of a failsafe number (Rosenthal, 1979) suggests that 162 studies would be required to reduce the observed r = 0.13 to non-significance, suggesting that the observed correlation is robust to studies missing, due to publication bias.

Figure 13.

Eggar's Funnel Plot of the Correlations Between Appropriate Mind-Mindedness and Attachment.



Note. The 95% confidence interval of the expected distribution of the correlations between appropriate mind-mindedness and attachment is shown as an inverted "funnel".

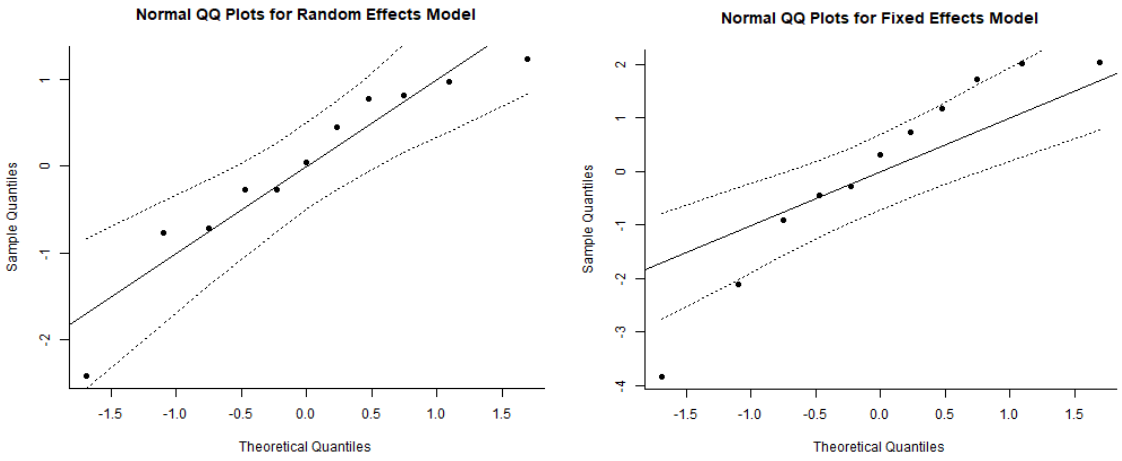
Meta-Analysis 4: Correlation Between Non-Attuned Mind-Mindedness and Attachment.

Selection of the Meta-Analytic Model

The distribution of primary study effects is shown in Figure 14. There is some evidence of non-linearity in the distribution of correlations using the fixed effects model, which is absent in the random effects model. Therefore, this indicates that the use of the random effects model and the REML of the between studies variation, is an appropriate method for the calculation of the variation of the true effect.

Figure 14.

QQ Plot of the Distribution of this Creation Between Non-Attuned Mind-Mindedness and Attachment Style within the Primary Studies.



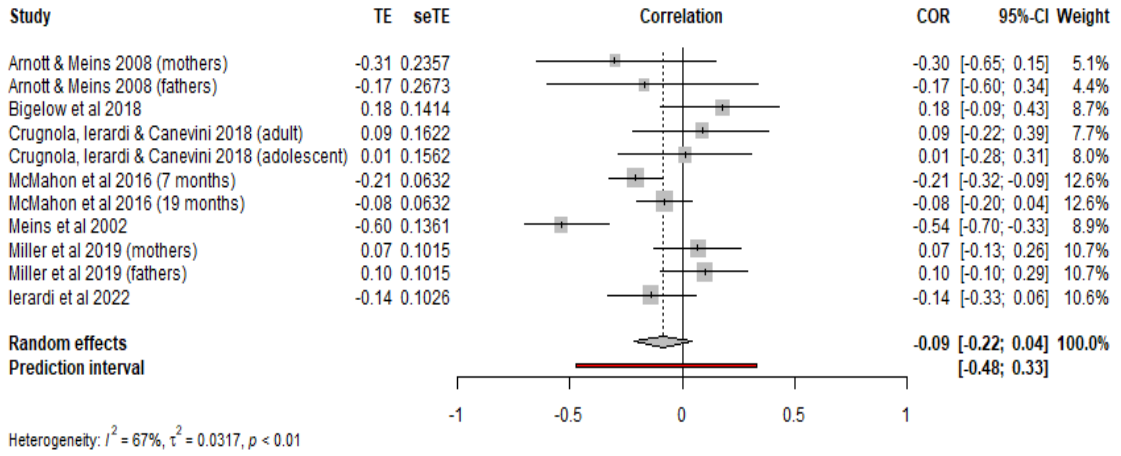
The Omnibus Test

The descriptives of the studies included in the analysis are reported in Appendix H. There were seven studies reporting 11 effects, in a total of 784 participants (Figure 15). Unlike meta-analysis 3, all participants involved in the studies were biological parents of the children included. Children were 12 months of age or younger at the time of testing, except in two studies. Three studies utilised an observational measure (Strange Situation or AQS) and four studies used a questionnaire or interview method, to assess attachment. All studies used an observational assessment of mind-mindedness, with one study (McMahon et al., 2016) incorporating an additional representational method to assess mind-mindedness. The random effects model suggested a non-significant weighted average correlation of $r = 0.09$ ($z = -1.30$, $p = 0.19$) and a 95% confidence interval of between -0.21 to 0.04. Between studies heterogeneity was reported ($I^2 = 67.4\%$ $tau^2 = 0.03$, $Q = 30.64$, $p < 0.01$). This suggests an acceptable level of variation in the primary studies, with this body of studies reporting a coherent and consistent effect size.

The impact of publication bias and risk of bias was not assessed for this data due to there being fewer than 10 studies, as recommended by Dalton, Bolen and Mascha (2017).

Figure 15.

Forest Plot of Non-Attuned Mind-Mindedness and Attachment



Note. A positive value indicates higher values for the secure attachment style, and a negative value indicates higher values of insecure attachment style.

Narrative Review

Papers that addressed the research questions of the review but did not provide data for any of the meta-analyses, are reviewed below.

Avoidance & Anxious Attachment Styles

Five papers explored attachment through the dimensions of avoidance and anxiety only. Three of these papers described no significant relationship between mind-mindedness comments and either anxious or avoidant attachment styles (Hill & McMahon, 2016, Szpack et al., 2017, & Zeegers et al., 2020). However, Meins et al. (2008) described the avoidance

attachment style as a predictor of the inclusion of mind-mindedness descriptors. They expanded that avoidance attachment scores were lower for those who included at least one mind-mindedness descriptor. Additionally, anxious attachment has shown to be negatively correlated with appropriate mind-mindedness comments (Dollberg, 2022).

Antenatal Measures

Antenatal measures were used in four studies. Two studies used antenatal attachment measures (Arnott & Meins, 2007; Dollberg, 2022), reporting no association between attachment security and non-attuned mind-mindedness. However, non-autonomous fathers (Arnott & Meins, 2007) and specifically anxiously attached mothers (Dollberg, 2022) have been found to make fewer appropriate mind-minded comments when interacting with their child. Conversely, Arnott and Meins (2007) found no significant relationship between mothers' attachment security and appropriate mind-mindedness. This is consistent with McNamara et al. (2022) and Arnott and Meins (2008) who also utilised an antenatal representational measure, 'describe your child in 6 months', to assess for mind-mindedness. However, providing prompts to parents resulted in a significant positive correlation with attachment (McNamara et al., 2022).

'Describe a close relationship and famous person'.

Three papers used the "descriptions of romantic partners, a close friend, and famous figures" (Hill & McMahon, 2016; Meins et al., 2008; Spak & Bialecka-Pikul, 2015). No relationship between the presence of mind-minded comments and anxious or avoidant attachment scores were reported (Hill & McMahon, 2016; Spak & Bialecka-Pikul, 2015). However, Meins et al. (2008) found avoidant attachment predicted the inclusion of mind-minded descriptions, with avoidance attachment scores being lower in those who included

mind-mindedness descriptors than those who did not include any. Hill and McMahon (2016) further explored the relationship between descriptors for child, partner and a famous person, reporting that participants used fewer mind-minded descriptors to describe a famous person, compared to a close relationship (child/ partner).

Regressions

Eight studies included regression analyses and produced mixed results, with regards to the level in which mind-minded comments predict or contribute to attachment security.

Appropriate mind-mindedness has shown to be a significant predictor of attachment security (Bernier & Dozier, 2003; Meins et al., 2001) and degree of disorganised attachment (Bigelow et al., 2018). However, antenatal mind-mindedness was not a significant predictor of maternal foetal attachment in the 3rd trimester (McNamara et al., 2022). When considering maternal age and risk of depression, appropriate mind-mindedness accounted for 15.4% of the variance in attachment (Bigelow et al., 2018). When entered after education and maternal sensitivity, Meins et al. (2001) found appropriate mind-mindedness accounted for 12.7% of attachment variance. When adding AAI coherence, this accounted for 15.2% of attachment variance (Bernier & Dozier, 2003).

Similarly, lower rates of non-attuned mind-mindedness and infant gender, specifically boys, predicted secure attachment (Meins et al., 2018). Additionally, non-attuned mind-mindedness predicted insecure attachment via their negative effect on children's symbolic play (Meins et al., 2018).

Results of attachment security predicting mind-mindedness also varied, with Demers et al. (2010) finding it accounted for 5.7% of the variance of mind-mindedness and McNamara et al. (2022) indicating no significant predictive results. Respect for autonomy partially mediated the relationship between use of mind-related comments and infant girls'

attachment security. However, no mediation effect was found for infant boys (Colonnesi et al., 2017).

Securely attached infants were distinguished from their insecure counterparts by lower frequency of maternal, non-attuned mind-mindedness and higher appropriate mind-mindedness (Shai & Meins, 2018). Higher scores of non-attuned mind-related comments were also associated with infants within the resistant attachment groups, compared to avoidant infants (Shai & Meins, 2018).

Discussion

Summary of Findings

This meta-analysis was the first to focus purely on the association between mind-mindedness and attachment security. The findings highlight a positive relationship between appropriate mind-mindedness and secure attachment, and non-attuned mind-mindedness with insecure attachment, with the non-attuned correlations trending towards significance. This is consistent with previous research (Arnott & Meins, 2007; Lundy, 2003; Meins et al., 2001, 2012, 2017, 2018). These results indicate that attributing internal states that appear to be consistent with an infant's current experience could be important in nurturing a secure relationship. Conversely, attributing internal states that appear to be at odds with an infant's current experience may suggest a disconnect between the parent and child; this could potentially influence their developing relationship. This disconnect would fit with Ainsworth et al. (1974) who suggested that the appropriateness of parents' responses and interactions with their infants are influential in fostering a secure attachment.

Zeegers et al. (2017) recommended exploring three or four-way classifications of attachment. As such, this meta-analysis conducted subgroup analyses to investigate any

differences in how different insecure attachment styles related to mind-mindedness. No subgroup differences were identified that related to insecure attachment subtype for appropriate or non-attuned mind-mindedness. Other studies also found no difference between insecure subtypes (anxious and avoidant) and their relationship with mind-mindedness (Hill & McMahon, 2016, Szpack et al., 2017, & Zeegers et al., 2020). This lack of variance between attachment styles could potentially reflect the complexity of attachment security, with multiple factors such as parental behaviour, sensitivity and the consistency of responses significantly influencing the expression of the different, insecure attachment styles (Ainsworth et al., 1978; Bowlby, 1988; Main & Solomon, 1986; Planalp et al., 2019; van IJzendoorn et al., 2004; van IJzendoorn & Bakermans-Kranenburg, 2019; Zeegers et al., 2017). However, due to high heterogeneity and low number of studies included in the analysis of non-attuned mind-mindedness, these results should be interpreted with caution.

Further subgroup analysis found no significant difference between the observational and the representational assessment measures of mind-mindedness, consistent with Meins & Fernyhough (2015). Additionally, no difference was found between the measures of attachment. However, antenatal measures of attachment were not included in the analysis due to the small number of studies reporting on these methods. There was a trend towards a significant difference between mothers and fathers (Figure 12). However, with such a limited number of studies including fathers, these results should be interpreted with caution and therefore we would hypothesise that paternal mind-mindedness is as important as maternal.

Limitations of the Evidence

This meta-analysis found no difference between the subgroups of attachment security, which may be due to the limited number of studies reporting between group data. In addition, there was inconsistency, with many studies not reporting on all subgroups and some reporting

attachment as a dichotomous variable (secure-insecure). Even fewer studies reported on non-attuned mind-mindedness.

As previously stated, fewer studies published non-attuned comments, exacerbating the above limitation. This lack of reporting could be due to the low frequency in which non-attuned comments tend to occur (Meins et al, 2012; McMahon & Bernier, 2017). McMahon & Bernier (2017) suggested that non-attuned comments could be analysed as a dichotomous variable in future research, as a way of increasing the frequency of reporting. Additionally, measuring mind-mindedness in attachment activating contexts may influence the presence of non-attuned comments (Bigelow et al., 2015; McMahon & Bernier, 2017; Milligan et al., 2015). Furthermore, Meins et al. (2012) and Marcoux et al. (2016) found that the frequency of non-attuned comments doubled in disorganised attachment styles and clinical populations. Therefore, this highlights the importance of including alternative populations, such as clinical and antenatal.

Less than a quarter of studies reported on the representational assessment of mind-mindedness. Therefore, more studies using this method may be required to identify a difference between measures. Additionally, Arnott and Meins (2008) suggested that the 'describe your child' question may not be sufficient to illicit mind-minded comments in an antenatal population. This opinion was supported by McNamara (2022) who only found a significant relationship between attachment and parental mind-mindedness when providing prompts to mothers. Furthermore, representational measure of mind-mindedness in non-parental populations, 'describe a close friend and/or famous person', found no significant relationship between mind-minded comments and attachment (Hill & McMahon, 2016; Spak & Bialecka-Pikul, 2015). Hill and McMahon (2016) also reported participants using fewer mind-minded comments to describe a famous person, compared to a close relationship (child/ partner). Therefore, the limitation of this element is twofold. Firstly, given the variance in

findings it is safe to conclude that there are insufficient studies involving the 'describe your child' question of mind-mindedness to yet fully understand any nuances that may influence attachment security, when compared to the observational measure of mind-mindedness. Secondly, there is a need to further explore mind-mindedness in non-parental populations, using the 'describe a friend/ famous person' question.

This review also highlights that fathers continue to be underrepresented in the literature when it comes to parent-child relationships. This lack of representation may reflect more traditional gender roles of parenting, typically viewing mothers as the main caregiver (Ainsworth et al., 1978), however this may not necessarily reflect more modern practices. Further research needs to be conducted involving fathers. Furthermore, as family systems evolve, with fostering and adoption increasing, and the main caregiver roles changing (children starting childcare earlier), it is important to understand the role of non-biological caregivers. With regards to different systems, cultural factors should be considered, as these have been found to influence mind-mindedness (Hughes et al., 2017; McMahon & Bernier, 2017) and attachment (Van IJzendoorn & Kroonenberg, 1988). Due to only two non-western samples included in the above analyses, this was unable to be explored further in the current review. These limitations are reflective of a broader shortcoming of diversity and difference within the literature.

Limitations of this Review

The findings of this review indicate that mind-mindedness is positively associated with the corresponding attachment styles (secure-insecure). However, the most relevant limitation in the present meta-analysis is the differing study designs, resulting in a limited number of studies being included in each meta-analysis and subsequent subgroup analyses. Given that the nuances in the relationship between mind-mindedness and the subgroups of attachment

security require further exploration, considerations with regards to methodology need to be made for future research.

The risk of bias assessment and consequent outcomes varied across studies and domains. All studies assessed mind-mindedness following Meins and Fernyhough (2015) but with varying approaches or populations that have not been validated according to the manual, which could affect the conclusions that can be drawn from the data. However, with the mind-mindedness concept still in its infancy, it felt important not to exclude such research. As the evidence base for mind-mindedness continues to expand, such contexts and populations could inform updates to the manual (Meins & Fernyhough, 2015).

This review began to investigate factors that could influence the relationship between mind-mindedness and attachment security, such as assessment methods and gender. However, due to the limited number of studies and inconsistency of demographic reporting, we were unable to conduct further analysis on other variables. There remain to be a multitude of factors such as population, mental health, and socioeconomic status which have shown to influence this relationship.

Implications for Clinical Practice

The relationship between attachment and mind-mindedness could have real world implication on the screening and assessment within clinical settings such as perinatal and mental health services, helping to more easily identify parents (due to higher proportions of non-attuned mind-mindedness) who may benefit from support and intervention. Additionally, the integration of mind-mindedness within the screening and assessment process for non-biological caregivers (foster parents, adoptive parents and childcarers) may help identify those who are able to model a secure attachment style for the children within their care. Furthermore, the inclusion into the training provided to such caregivers could help foster

more positive and secure relational patterns, potentially leading to improved relationships and less placement breakdowns. The association between mind-mindedness and attachment security also has clinical implications for the current attachment interventions, due to the integration of mentalisation methods (Schacht et al., 2017). Such interventions could in part be evaluated by exploring if there has been a reduction in non-attuned mind-mindedness and an increase in appropriate mind-mindedness.

Implications for Future Research

This meta-analysis was the first to purely focus on the relationship between mind-mindedness and attachment, as mentioned earlier, indicating a positive relationship between mind-mindedness and attachment. However, the review highlighted areas that may be of interest to future research which will be summarised here.

Zeegers et al. (2017) suggested that 112 or more participants are required for the detection of a medium to large effect for parental mind-mindedness, between the four attachment styles. Therefore, the need for large-scale studies should be a consideration for future research in addition to consistency in reporting on attachment subgroups. Furthermore, to increase the reporting of non-attuned mind-mindedness, it has been suggested that this be analysed as a dichotomous variable, present or not (McMahon & Bernier, 2017).

Additionally, a method of measuring mind-mindedness in attachment activating contexts may influence the presence of non-attuned comments (Bigelow et al., 2015; McMahon & Bernier, 2017; Milligan et al., 2015). Furthermore, consideration could be given to assessing such a relationship in various populations, as the frequency of non-attuned mind-mindedness increases within clinical populations (Marcoux et al., 2016; Meins et al., 2012). Therefore, as indicated by the review, future research should seek to explore this relationship amongst clinical populations, fathers, antenatal and non-biological populations. In a broader context

with the construct of mind-mindedness continuing to develop, it feels important to continue to expand upon areas as validated by Meins & Fernyhough (2015), to investigate the boundaries and limitations of the measure. The current review wished to gain a holistic view on the relationship between mind-mindedness and attachment and therefore included studies reviewing adult attachment as well as parent-child attachment. Analyses did not identify any particularly influential studies or studies with a high risk of bias that would have warranted their exclusion in the review. Therefore, there appeared to be no reason to exclude either sample. However, future research may wish to focus on the parent-child attachment and mind-mindedness literature only for further specificity on this relationship.

Conclusion

The findings of this review indicated that higher scores of appropriate mind-mindedness were associated with being more securely attached. Conversely, higher scores of non-attuned mind-mindedness were associated with more insecure attachment styles. No differences were identified across attachment subgroups. Mind-mindedness is a crucial factor to consider in understanding the 'transmission gap' and parent-infant relational development, more broadly.

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The Relationship between Sleep and Mind-Mindedness in New Mothers

Abstract

Rationale

Sleep impacts physical and mental health, including socio-emotional cognitive functions, mood and ability to manage stress. Such processes are required to recognise and appropriately interpret the internal states of others, such as preferences and emotions. This tendency to understand infants as driven by their internal mental states is known as 'mind-mindedness'. Given the tendency for new mothers to experience significant sleep changes, it is important to explore if such sleep changes impact on new mothers' ability to be mind-minded towards their new-born.

Method

Thirty expectant mothers were recruited through the snowballing of social media adverts, with the support of NCT and BASIS. A within-subjects design was used to record new mothers' sleep during their third trimester (T1) and postpartum (T2, within 100days after birth). Objective sleep data were collected with the use of Actiwatches or Oura rings, whilst subjective sleep was recorded with the use of sleep diaries. Mind-mindedness observations were conducted via Zoom when infants were approximately three months old.

Results

Results indicate a significant increase in Wake After Sleep Onset and a significant decrease in Sleep Efficiency recorded via Actiwatch and sleep diary. Appropriate and non-attuned mind-mindedness were analysed for their relationship with these changes and sleep variables,

measured at T2. Non-attuned mind-mindedness was significantly related to multiple sleep variables. Appropriate mind-mindedness did not significantly correlate with any sleep variables.

Discussion

The results provide insight into the relationship between sleep and mind-mindedness. Despite the limited sample size (N = 30), these results offer preliminary evidence suggestive that non-attuned mind-mindedness is associated with poorer sleep. Future research should consider exploring the relationship between sleep and mind-mindedness with a larger sample. A larger sample would also assist in the investigation of influential factors, such as culture and Socio-Economic Status.

Introduction

Poor sleep significantly impacts numerous aspects of a person's cognitive functioning, mood, and ability to manage stress (Lim & Dinges, 2010; Lyall et al., 2018); all these abilities are required to interpret other people's internal states, appropriately (Killgore et al., 2017). New mothers can experience significant sleep changes (Parsons et al., 2023), which likely impact their cognitive and emotional functioning (Deliens et al., 2015; Killgore, 2017). The tendency to understand infants, as driven by their own internal mental states, has been described as mind-mindedness (Meins 1999, 2013; Chapter one). It is important to know whether sleep loss affects new mothers' ability to be mind-minded. This study aims to understand the relationship between sleep changes and maternal mind-mindedness.

The Importance of Sleep

Sleep is necessary for healthy functioning, physically and mentally (Cirelli & Tononi, 2017; Grandner et al., 2018; Lyall et al., 2018; Pillai et al., 2017; & Sprecher et al., 2017). Sleep is a significant time of restorative activity, affecting learning and memory (Landolt & Dijk, 2019), with short-term sleep deprivation negatively affecting a wide range of cognitive processes (Lim & Dinges, 2010). Lower quantity or quality of sleep has been shown to impact on cognitive abilities; reducing vigilance, and impairing memory and decision-making (Franzen et al., 2008; Harrison & Horne, 1998; Harrison & Horne, 2000; Horne & Petit, 1985; Killgore et al., 2006 & Lim & Dinges, 2010). Inadequate sleep also impacts social and emotional cognition, affecting the capacity to understand and interact with others (Deliens et al., 2018; Killgore, 2010). Emotional intelligence and recognition are impaired following a period of sleep deprivation (Beattie et al., 2015 & Killgore et al., 2008). Additionally, after a period of sleep deprivation, activity in the amygdala has been shown to increase, which may be linked to an increase in emotional reactivity (Beattie et al., 2015).

Most research on sleep and cognition is undertaken with the general adult population (Kaliyaperumal, 2017) and in laboratory settings, meaning participants experience short-term, acute (often total) sleep deprivation (Beattie et al., 2015; de Almondes et al., 2016). This type of sleep deprivation differs from what would be expected in a healthy adult population, which is more likely to be partial or chronic sleep disturbance as opposed to total and acute. A key example of this is new parents, who experience more sleep disturbances, compared to controls (Insana, 2011).

Sleep Deprivation in New Mothers

Parenthood typically causes a sudden transition, presenting an array of new challenges and stressors (John et al., 2005). Such changes include the balancing of tasks, developing a sense of self as a parent and being able to interact with a new child (Grice et al., 2011). A new mother will need to learn to understand and interpret the new baby's non-verbal cues and cries and act upon these appropriately, to meet the needs of the child (John et al., 2005). In addition, following the arrival of a new child, mothers can experience altered sleep patterns and a loss of total sleep (Bei et al., 2012; Matsumoto et al., 2003; Signal et al., 2007), with such changes in sleep quality and duration being evident up to six years after the birth of a child (Richter et al., 2019). These sleep changes are likely to be influenced by the baby's sleep and feeding patterns (Ball, 2010; Meltzer & Mindell, 2007), with parents needing to attend to the needs of the child. This night-time feeding, after sleep onset, means new mothers can experience fragmented sleep, with more time spent awake following onset of sleep (Calcagni et al., 2012; Matsumoto et al., 2003; Park et al., 2013). Fragmented sleep is associated with poorer sleep outcomes (Kendall-Tackett et al., 2011) with sleep known to be more restorative when consolidated and not fragmented (Lim & Dinges, 2010).

Impact of Poor Sleep on Mother and Child

Sleep disturbances during pregnancy and after birth have been shown to impact negatively on both the mother and child's health and wellbeing (Calcagni et al., 2012; Kendall-Tackett et al., 2011; Lawson et al., 2015; Meltzer, Williamson & Mindell, 2021). Poor maternal sleep is strongly associated with mental health difficulties, including lower mood, increased anxiety and postnatal depression (González-Mesa et al., 2019; Lawson et al., 2015; Meltzer & Mindell, 2007; Okun, Luther et al., 2011 & Park et al., 2013). Additionally, mothers describe higher levels of stress and fatigue associated with disturbed sleep (Meltzer & Mindell, 2007).

Sleep can improve perspective-taking, emotional intelligence, and empathy, all of which have a role in socio-emotional functioning (Deliens et al., 2018; Guadigni et al., 2014 & Killgore et al., 2017). Such functions include a person's ability to recognise and respond appropriately to another's emotions (attunement) (Killgore et al., 2017). This ability to infer what others may be feeling or thinking, is part of our mentalisation abilities (Zeegers et al., 2017) and is likely to affect a child developing their own beliefs and skills in emotion recognition (Castro et al., 2015). Furthermore, tired mothers can feel most at risk of negatively responding to their child (Oldbury & Adams, 2015).

Mothers who demonstrate 'emotional availability' show higher levels of infant-attachment security (Hoffman et al., 2017; Ziv et al., 2000). Additionally, sleep deprived mothers have reported lower levels of attachment with their babies (Tikotzky et al., 2015). Research indicates that parent-child attachment security can be, in part, predicted by mentalisation, which is thought to provide a child with a sense of emotional security (van IJzendoorn et al., 2004). Given the cognitive processes involved in such abilities and the negative impact of sleep deprivation on such processes (Deliens et al., 2015; Killgore, 2010), it could be hypothesised that one ability, particularly impacted by poor sleep, is the ability to respond to

emotions accurately (Killgore et al., 2017). As such, this could have a significant impact on new mothers and therefore the effect of poor sleep has real-world implications.

Mind-Mindedness

Drawing upon attachment and social-cognitive theories, Meins (1999) proposed the concept of mind-mindedness, which refers to a caregiver's tendency to treat their child as if they have a mind of their own. Maternal mind-mindedness differs from other measures of parental mentalisation given its emphasis on verbalisations about their child's mental state, rather than behaviour (Meins, 2013). Mind-mindedness facilitates the interpretation of an infant's actions that are driven by their internal state, such as emotions, preferences, and goals (Meins 1997, 2013). The ability to understand others' mental states has been shown to be a purposeful process (Apperly & Butterfill, 2009; Epley, Keysar, van Boven, & Gilovich, 2004; Keysar, Lin, & Barr, 2003; Lin, Keysar, & Epley, 2010).

This interpretation enables caregivers to adapt their responses to the child's behaviour, appropriately. This construct has been demonstrated to make independent predictions on parent-child attachment security (Meins et al, 2001; Zeegers et al., 2017). Appropriate mind-mindedness has been associated with more secure attachment. Conversely, non-attuned mind-mindedness has been associated with more insecure attachment (Chapter one). Additionally, Aldrich, Chen & Alferi (2021) conducted a meta-analysis providing evidence that parental mind-mindedness is related to the development of children's social cognition, executive functions and language abilities.

Sleep and Mind-mindedness

Parent and child relationships early in life are known to have long-term consequences on the child's psychological and physical health (DeKleyn & Greenberg, 2008; Lawson et al., 2015; Lyons-Ruth & Jacobvitz, 2008). Relationships between parent and child are made up of interconnected components, including the interactions and internal representations of both mother and child (Zeanah, 2000). Sleep improves perspective-taking (Deliens et al., 2018), emotional intelligence (Killgore et al., 2017) and empathy (Guadigni et al., 2014). Each of these processes and many more are linked, with a tendency to think accurately about the minds of others and therefore may impact a mother's ability to respond appropriately to her child's emotional and physical needs. Consequently, there are good reasons to believe sleep may predict mind-mindedness in new mothers. However, the relationship between poor sleep and mind-mindedness is yet to be explored.

Rationale

Given that mind-mindedness uses a range of socio-emotional cognitive functions that are impacted by poor sleep, it is reasonable to hypothesise that poor sleep may impact on maternal mind-mindedness. The current study aims to understand the relationship between sleep changes and maternal mind-mindedness. It is hypothesised that new mothers will have shorter and more disrupted sleep, when compared to their sleep prior to the birth of their child. This change in sleep may impact on the mother's ability to engage mindfully with their child. As such, it is predicted that poorer sleep is associated with poorer maternal mind-mindedness.

Method

The study used a within-subjects design, recruiting first-time mothers for a first testing session in their third trimester of pregnancy (T1). At this point, their sleep was measured. Sleep was measured again in the first 100 days following their child's birth and a measure of mind-mindedness taken. This study was pre-registered on the Open Science Framework on 27th October 2021.

Participants

Participants were recruited through the snowballing of social media adverts with the support of the National Childbirth Trust (NCT) and Baby Sleep Information Source (BASIS). Recruitment took place between January 2022 and January 2023. The study was open to any first-time expectant mothers residing in England, Wales, Scotland and Isle of Man, at the time of recruitment. No other inclusion criteria were specified. Thirty-five participants consented to take part in the study, five of whom either withdrew or gave birth prior to completing the study. Basic demographic data such as age, ethnicity and language were collected for the thirty participants included in the study; these are summarised in Table 8. Due to the complex nature of the study and the new challenges faced by the participants it felt pertinent not to overwhelm the participants with additional information requests. As such, although several variables such as sing/co-parenting, bottle/breast fed, parent mental health, multi-generational households were of interest to the research, this data was not collected.

All participants identified as female and ranged in age from 24-41 years (M=32.5, SD=3.5), with all mothers being in their third trimester at T1 testing. Ethnicity was categorized into 10 groups, those that applied to the participants were summarised below (Table 8). English was identified as the first language of 90% of participants. For the purpose of this study, adoptive parents were not excluded as long as they met the above criteria, and

their child was under 100 days old during the study period. However, no mothers who took part in the study identified themselves as adoptive parents. On gaining consent, participants were allocated an ID number for anonymity and confidentiality purposes.

Table 8.

Descriptive Data of Participants

Age	M=32.5, SD=3.5 (24-41)
Ethnicity	
White British	24
White other	4
Asian or Asian British - Chinese	1
Other mixed or multiple ethnic background	1
Language	
English	27
Italian	1
Polish	1
Russian	1

Measurements

Objective Sleep

Objective sleep devices were used to estimate total sleep time (TST), wake after sleep onset (WASO), sleep onset latency (SOL), time in bed (TiB), and sleep efficiency (SE), matching the factors calculated using the sleep diaries. Recent research has demonstrated the value of such devices in the monitoring of sleep (de Zambotti et al., 2019; Kosmadopoulos et al., 2014; Quante et al., 2018). For reasons of equipment availability, two different devices, Oura rings and Actiwatches were employed. Both devices demonstrate similar biases with regards to the overestimation of TST and WASO (Chee et al., 2020). Both devices have been optimised for the adult population (Chee et al., 2020). The number of nights recorded using

objective measures, pre-birth, ranged between 3 and 7 (M=6.59, SD=1.10) and post-birth, 4 and 7 (M= 6.70, SD=0.80). To increase the reliability of data, it is recommended that a minimum of five consecutive nights sleep is recorded, using the actigraphy device (Sadeh, 2011). The study aimed to record seven nights of sleep per participant. For 7 participants, fewer than 5 nights of sleep were recorded; this was due to technical errors with the actigraphy devices and babies being born early. Where seven nights of recordings were not achieved, data were included, given the small sample size.

Actiwatches

Actigraphy devices in the form of Actiwatch Spectrum Plus were used as an objective measure of sleep for 18 participants. Actigraphy devices use an accelerometer and photoplethysmography (PPG) to measure movement that contributes to sleep-wake detection (Chee et al., 2022). These devices allow for a reliable and validated method of electronically recording sleep data that correlates well with polysomnography, which is considered the gold standard for sleep research (Azimi et al, 2019; Chee et al., 2020; & de Zambotti et al., 2019). Unlike polysomnography, these devices are discreet and non-invasive, that can be worn on the user's wrist and therefore can be used at home with minimal input from the participant (Martin & Hakim, 2011 & Smith et al., 2018). Actiwatch data were collected in 30-second epochs and scored using the Actiware software (version 6.3.0, Philips Respironics Inc, Pittsburgh, Pennsylvania). Two wake thresholds and immobility settings were applied for actigraphy data processing. The default M10 setting uses a medium wake threshold, with 40 counts per epoch with 10 immobile minutes for sleep onset and termination. Total sleep time (TST) was calculated as the summation of sleep epochs within the designated sleep periods. Wake after sleep onset (WASO) was calculated as the summation of wake epochs between sleep onset and end of the wake period. Data was cleaned according to Actigraphy Cleaning

Protocol (Trickett et al., 2017; Appendix I), using sleep diaries to increase the reliability of recordings (Sadeh, 2011).

Objective Sleep - Oura Rings

Oura rings are small, non-invasive and do not require the user's actions to detect sleep (Smith et al., 2018). Oura rings use infrared light photoplethysmography (PPG) to record heart rate, respiration rate, body temperature and an accelerometer to measure movement to estimate sleep duration, quality and efficiency (Chee et al., 2020; de Zambotti et al., 2019; Roberts et al., 2020). App version 4.9.4 of the Oura App and firmware version 4.0.8 for the Oura ring were used throughout the duration of this study. Thirty second epoch by epoch data was obtained from Oura's cloud. The Oura ring classifies sleep epochs into four categories of sleep: wake, light, deep, and REM sleep. Sleep onset was defined as the first epoch of sleep, regardless of stage. Nine participants used Oura rings to collect objective sleep data at both testing periods. For the purpose of analysis, data obtained from both objective measures (Oura and Actiwatch) were combined.

Subjective Sleep

Participants were asked to use sleep diaries to record their sleep for a 7-night period (Appendix J). When using a sleep diary, it is suggested that a minimum of six nights be recorded (Aili et al., 2017). For 11 participants, fewer than 5 nights of sleep were recorded. Where seven 7 nights of recordings were not achieved, data were included, given the small sample size. The average number of nights recorded using the sleep diaries, pre-birth, ranged between 0 and 7 (M = 5.90, SD = 2.04) and post-birth, 0 and 7 (M = 5.68, SD = 2.31).

Sleep diaries are a valuable measure to inform how participants perceive their sleep. Participants were asked to record the time they got into bed and retrospectively estimate the

time they fell asleep, any periods of waking during the night, final waking time and time they got out of bed. Total Sleep Time (TST) was defined by the total sleep recorded, following the onset of sleep. This did not include any periods of waking during the sleep period, or any daytime naps. Sleep Onset Latency (SOL) was defined as the period spent awake in bed, before the initial sleep onset. Wake After Sleep Onset (WASO) was defined as the total amount of time awake, following the initial onset of sleep. Reed and Sacco (2016) recommend calculating Sleep Efficiency (SE) by dividing the total sleep time (TST) by the time spent in bed (TiB) x 100. Therefore, the total and average for TST, SOL, WASO, and SE recorded, via the sleep diary, were calculated for all participants and compared to the same factors for the actigraphy devices. The sleep diary used alongside actigraphy can increase reliability of the device in the event of device malfunction, or periods of motionless activity being mistakenly recorded as sleep (Aili, et al, 2017; Martin & Hakim, 2011; Sadeh, 2011).

Mind-Mindedness

Maternal mind−mindedness refers to the mother's proclivity to comment appropriately on her infant's mental states (Meins et al., 1997). Participants were requested to take part in an observation from their own home where they were observed interacting with their 3-month-old infant, in a 5-minute free-play session. Mothers were given no specific instructions on how to act during this session, other than being asked “to play with your child as if you had a spare few minutes together”. This observation was recorded and later transcribed. Once transcribed and coded, video-recordings were deleted. Participants’ comments were coded for maternal mind-mindedness, according to the criteria set out by Meins and Fernyhough (2015). A comment was defined as a discrete sound, a single word or sentence. Comments were then categorised into desires, cognitions, emotions, epistemic states and talking on the

infant's behalf or not mind-related, according to the mind-mindedness manual (Meins & Fernyhough, 2015). Furthermore, comments were classified as appropriate or non-attuned mind related. An appropriate mind-related comment refers to a current activity, an inference to a child's internal state that the researcher agrees with and a comment clarifying how best to proceed. Non-attuned mind-related comments refer to when the caregiver does not seem attuned to the child's current states. For example, the caregiver saying "you like that" when the child has shown no interest in the object, or suggesting the child wants to become involved in a new activity, when already actively engaged in an activity (Meins & Fernyhough, 2015).

Meins and Fernyhough (2015) coding system for mind-mindedness has been well validated. Aldrich, Chen & Alferi (2021) suggest that the representational and interactional methods of assessment were to be equivalent in assessing the construct that is mind-mindedness. Furthermore, previous studies have shown good inter-rater reliability and stability over time (McMahon & Bernier., 2017; Kohlhoff et al., 2020).

Procedure

Ethical approval for this study was provided by the University of Birmingham Science, Technology, Engineering and Mathematics ethics committee (ERN_21-1164; Appendix K).

Prospective participants contacted the researchers to express their interest in partaking in the study. Their eligibility for inclusion was checked and, if appropriate, they were emailed an information sheet and consent form and asked to confirm their due date. On return of a signed consent form, participants' ring sizes were obtained to identify a best fit device.

When participants were approaching their third trimester (T1), they were contacted to arrange for the actigraphy equipment to be sent out and a first night of recording agreed. An email followed, to confirm the conversation and access to a Qualtrics link for participants to

complete demographic information. Participants were sent either an Oura ring or an Actiwatch, in the post. Instructions were provided, with directions on charging the device and for it to be worn on their non-dominant hand, between 4pm and 10am, and to remove the device if engaging in activities that may involve the actigraphy being fully submerged in liquid. Participants were also asked to complete a sleep diary during this same period. After seven days of recordings, participants were instructed to place the actigraphy device and sleep diary in a pre-paid envelope and to return it to the research team. Participants were encouraged to contact the researchers if they had any questions.

Approximately six weeks after the prospective due date, participants were emailed the information sheet and consent form, to take part in T2 of the testing procedure. On return of the consent form, researchers contacted participants to arrange for a convenient time to undertake T2 testing approximately 3 months after the birth of the child. This timeframe reflects a period in which parents report experiencing high levels of disturbance in their sleep, in addition to being a critical period of development for the child. This included participants repeating the sleep recordings described in T1 and undertaking a 5-minute parent-child observation via Zoom video conferencing software. During the Zoom video, participants were asked to change their screen name for the purpose of anonymity. At the end of the procedure, participants were thanked for their time and the researcher reiterated the contact details, should they have any further questions regarding the research. Participants were sent a £10 Amazon voucher, as a thank you for their participation.

Sample Size, Attrition and Missing Data

Power analysis completed using g*power to assess sample size to identify a medium effect size ($d = 0.5$) in the t-test, suggests the need of $N>38$, to give power $(1- \beta) = 80\%$, with $p < .0167$ (Bonferroni corrected for 3 dependent variables). Power analysis completed using

g*power to assess sample size to identify a medium-large effect size, (r = 0.4) in the correlation, suggests the need of N>49, to give power (1- β) = 80%, with p < .0167 (Bonferroni corrected for 3 dependent variables). Initial power analysis prescribed sample size was not met, due to difficulties with recruitment and missing data. In the event that recruitment was less successful than planned, provided sufficient data is acquired to test for large effect sizes under equivalent conditions to above (d = .8, suggests >17 participants required for t-test) and (r = .5 suggests >29 participants required for correlation).

Thirty-five individuals consented to participate in the study. Of these 35 participants, four were unable to take part due to giving birth before completing T1. One participant withdrew prior to completing T1. Thirty participants provided either full or partial data for the study. Of the 30 participants who completed the study, five withdrew from the study after giving birth, citing health complications and difficulties in managing recent changes, resulting in a total of 25 participants at T2.

Sleep diary data were available for 28 participants at T1, and 25 at T2. Complete actigraphy data were only available for 18 participants, due to data not being on the device upon its return. All participants that took part in T2 (N=25) participated in the mind-mindedness task; four of these were unable to be coded due to technical or audio issues with the video recording.

Consequences of missing data are reflected in sample size differences across different analyses. For instance, comparisons between objective sleep at T1 and T2 were possible across all participants who did not withdraw and for whom objective data recorded successfully at both time points (N=18). Comparatively, for instance, a correlation between change in objective sleep across timepoints requires objective sleep data at T1 and T2, and successfully coded for mind-mindedness (N=14).

Data Processing and Analysis

Change in sleep was calculated by subtracting T1 from T2 values. Therefore, higher values for TST and SE would suggest better sleep post-partum, and higher values of WASO suggest poorer sleep post-partum. Sleep Onset Latency values are somewhat more difficult to interpret and as such were included in the t-test analyses but not the association with mind-mindedness.

Data analysis consisted of a paired samples t-test to analyse the changes in sleep pre and post birth between sleep. Additionally, correlational analysis was used to explore the relationship between mind-mindedness and sleep variables. Due to numerous variables returning significant results for the Shapiro-Wilk test (Shapiro & Wilk, 1965; Appendix L), a normal distribution could not be assumed. Therefore, Spearman's Rank correlations were conducted to analyse the relationship between variables.

Conducting multiple comparisons within a single family of tests can increase the chance of type one error. Employing a strict Bonferroni correction would increase the chance of type-2 error. A compromise approach was taken (as per Surtees et al., 2019). The more stringent $p < 0.01$ criterion was used to determine significance. Findings reporting $p = 0.05$-0.01 were identified as trends and considered in line with consistency of results overall.

For paired samples tests, 2-tailed significance testing was undertaken, as a conservative approach, open to the possibility that changing circumstances could elicit some positive changes to sleep, and a variable such as SOL is not clearly a positive-negative spectrum in any case. For correlations, 1-tailed significance testing was undertaken. This was based on assumptions that appropriate mind-mindedness would relate to "good" sleep and non-appropriate to "bad sleep". This approach reflected the lack of theoretical coherence consistent with poor sleep relating to good mind-mindedness, meaning such correlations would likely be spurious.

Results

Sleep Parameter Estimates and Change in Sleep between T1 and T2

A summary of objective and subjective sleep data from both periods (T1 & T2) is presented in Table 9. Data were compared to identify any changes in sleep across TST, WASO, SOL and SE (Table 9). These data demonstrate some differences in mothers' sleep before and after the birth of their child. The objective data demonstrated a significant increase in WASO and a trend for a decrease in SE. These results are mirrored in the subjective sleep data. There was no evidence for a change in TST or SOL. Overall, there was evidence that mothers experienced more disrupted sleep postpartum, evidenced by significant increases in waking and consistent trends for decreases in efficiency of sleep. There was no evidence for change in overall sleep time or latency to sleep.

Correlations between equivalent subjective and objective measures of sleep were conducted (Appendix M). There was mixed concordance between measures across all sleep elements, with correlations ranging from r = 0.69 (0.001) for TST , r = 0.31 (0.13) for Sleep Efficiency and r = 0.11 (0.60) for Wake After Sleep Onset at T1. At T2 correlations ranged from r = 0.14 (0.58) for TST, r = 0.48 (0.10) for Sleep Efficiency and r = 0.68 (0.002) for Wake After Sleep Onset. Moderate coefficient between 0.40-0.69. Correlations between 0.70-1.00 would indicate a strong relationship (Schober et al., 2018).

Table 9.

Summary of Subjective and Objective Sleep Data for Antenatal and Postpartum Testing Periods.

	Full sample		**Paired Sample**				
	T1	T2	T1	T2	Change	t	p
	N = 26	N =20	N=18	N=18	N=18		
TST^{Acti}	7.17(0.41)	7.27(1.05)	7.10(0.37)	7.23(0.59)	0.13 (0.60)	0.96	0.17
$WASO^{Acti}$	**50.45(15.36)**	**77.12(34.65)**	**50.06(13.37)**	**79.24(34.84)**	**29.17 (31.78)**	**3.90**	**<0.01****
SOL^{Acti}	17.00(11.91)	16.45(8.70)	17.21(13.74)	15.43(7.53)	-1.78 (12.69)	-0.60	0.28
SE^{Acti}	**84.04(3.80)**	**81.15(4.94)**	**83.87(4.16)**	**80.94(4.88)**	**-2.93 (5.21)**	**-2.38**	**0.02***
	N = 28	N = 25	N=25	N=25	N = 25		
TST^{Diary}	7.02(0.51)	6.55(1.05)	6.59(0.49)	6.55(1.06)	-0.05(1.12)	-0.33	0.37
$WASO^{Diary}$	**32.63(25.30)**	**90.60(46.06)**	**32.97(25.58)**	**89.47(46.63)**	**56.50(59.61)**	**4.74**	**<0.01****
SOL^{Diary}	46.16(36.76)	49.21(39.01)	50.50(37.66)	50.91(38.90)	0.42(42.68)	0.48	0.48
SE^{Diary}	**77.97(9.20)**	**70.89(11.75)**	**76.77(8.86)**	**70.71(11.97)**	**-6.05(12.99)**	**-2.28**	**0.02***

Note. Mean and (Standard deviation) of sleep variables.
*Trends: paired samples t-test is significant at the 0.05 level (2-tailed)
** Significant results: paired samples t-test is significant at the 0.01 level (2-tailed).

Mind-Mindedness

With respect to the mind-mindedness observations, Table 10 shows the mean proportion of mind-minded comments when controlled for verbosity. Seventeen participants produced non-attuned mind related comments which accounted for 74% of the sample.

Table 10.

Mean and Standard Deviation of Mind-mindedness

Appropriate MM (N=23)	M = 0.07, SD =0.03	(0.02-0.13)
Non-attuned MM (N=23)	M = 0.02, SD =0.02	(0.00-0.07)

Note. MM = Mind-mindedness

Correlations between Mind-Mindedness and Sleep

Correlation analyses between mind-mindedness and sleep are summarised in Table 11. Given the non-normal distribution of data, Spearman's rho was used. Schober et al. (2018) define a weak correlation as being between 0.10-0.39 and a moderate coefficient between 0.40-0.69. Correlations between 0.70-1.00 would indicate a strong relationship.

Appropriate Mind-Mindedness

No significant correlations or trends were found between appropriate mind-mindedness and objective measures of either change in sleep or Time 2 sleep; all correlations fell within the weak-no correlation range. The direction of correlations showed no clear pattern. Similarly, no significant correlations or trends were found between appropriate mind-mindedness and subjective measures of either Time 2 Sleep or change in sleep. Again, all correlations fell within the weak-no correlation range. Here, there was some evidence of a broadly consistent pattern, with all weak correlations trending towards an association between worse sleep and less appropriate mind-mindedness.

Table 11

Summary of Spearman Correlations between Sleep and Mind-mindedness

	Appropriate MM (%)		Non-attuned MM (%)	
	Objective	Subjective	Objective	Subjective
	N = 14	N = 21	N = 14	N = 21
	ρ(*p*)	ρ(*p*)	ρ(*p*)	ρ(*p*)
TST Change	0.17(0.28)	-0.01(0.49)	-0.42(0.07)	-0.002(0.50)
SE Change	-0.29(0.16)	-0.08(0.36)	-0.20(0.47)	0.19(0.21)
WASO Change	-0.13(0.32)	0.20(0.19)	0.74 (<0.01)**	-0.13(0.28)
	N = 16	N = 21	N = 16	N =21
TST T2	0.1(0.36)	-0.16(0.24)	-0.50 (0.03)*	0.14(0.27)
SE T2	0.23(0.20)	-0.14(0.27)	0.22 (0.20)	0.42(0.03)*
WASO T2	-0.24(0.18)	0.09(0.35)	-0.19 (0.24)	-0.13(0.29)

Note. * Correlation is significant at the 0.05 level (1-tailed)
** Correlation is significant at the 0.01 level (1-tailed).
Red and pink shading indicates a negative relationship between mind-mindedness factor and 'good sleep', green shading a positive relationship to 'good sleep'. Bolder colours are used to represent stronger relationships, with categories in line with Schober et al. (2018).

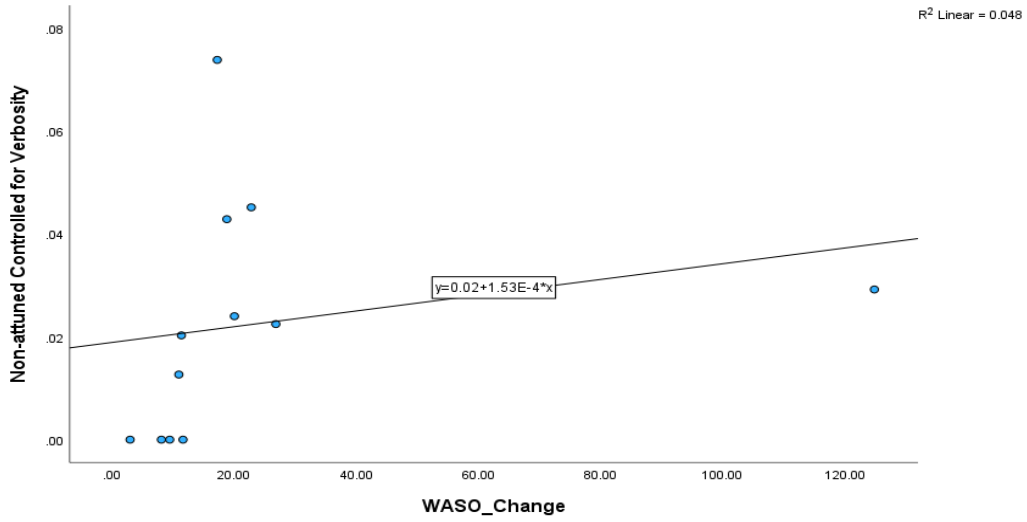
Non-attuned mind-mindedness

Non-attuned mind-mindedness strongly (Schober et al., 2018) and significantly correlated with change in objectively measured WASO, indicating a larger increase in night waking was associated with a higher frequency of non-attuned mind-mindedness (Figure 16). Other variables associated with change in objective sleep were not significantly correlated to non-attuned mind-mindedness but were consistent in direction. T2 objectively measured TST showed a trend for a negative and moderately sized correlation to non-attuned mind-mindedness. Other measures of T2 sleep showed no trend for an association with non-attuned mind-mindedness and were not consistent in directionality.

Subjective measures of change in sleep did not correlate to non-attuned mind-mindedness. There was no consistent pattern in the relationships observed and all correlations were weak in strength. T2 SE data showed a trend for correlating positively with non-attuned mind-mindedness. Notably, the trend here runs counter to predictions – so is not considered further. Other variables showed weak evidence, with a consistent directionality.

Figure 16.

Scatter Plot with Fit Line Median of Non-attuned Mind-mindedness by Change in WASO



Discussion

This study provides the first insights into the relationship between sleep and mind-mindedness in new mothers. Despite the limited sample size, these results offer preliminary evidence that non-attuned mind-mindedness is related to worsening of objectively measured sleep, specifically an increase in Wake After Sleep Onset.

Summary of Findings

Sleep in New Mothers

Sleep data were recorded in first time mothers during their third trimester and in the first 3-months post birth, using both sleep diaries and objective sleep measures (Actiwatch or Oura ring). The objective and subjective sleep data provided some evidence of sleep changes between pre-and-post birth periods, consistent with the literature (Park et al., 2013; Parsons et al., 2023). The findings show a significant increase in time spent awake after the birth of the child and a trend towards a significant decrease in sleep efficiency, providing evidence to support the hypothesis that new mothers spend a larger duration of time awake after sleep onset, compared to their third trimester. Additionally, it was hypothesised that as a result of increased WASO, mothers would experience a decrease in their sleep efficiency at T2. Such findings would be consistent with previous findings (Park et al., 2013; Parsons et al., 2023).

Analysis of concordance between objective and sleep measures produced mixed results (Appendix M). Such results indicate that new mothers with poor sleep do not accurately report their sleep. However, consistency across objective and subjective measures of sleep provided some evidence that the findings for change in sleep are somewhat reliable.

Interestingly, there was no evidence for change in TST. Similar results have been reported in previous research (Doan et al., 2007; Krawczak et al.,2016; Park et al., 2013; Sharkey et al., 2013). In a meta-analysis of studies, Parsons et al. (2023) found that on average TST does decrease after the birth of a child, however, there is much more variability across studies. That we did not find a difference is perhaps evidence of cultural differences – notably, no previous studies have reported change in sleep between pregnancy and birth in UK mothers.

Nevertheless, the results below provide some evidence to support hypotheses that mothers would experience sleep changes after the birth of their child, specifically experiencing more disrupted sleep.

The relationship between sleep and mind-mindedness

Analyses produced no significant associations between appropriate mind-mindedness and sleep and all correlations fell within the weak range, indicating that individual differences in sleep or changes in sleep do not seem to predict appropriate mind-mindedness. However, mothers experiencing poor sleep used appropriate mind-related comments does not necessarily mean they did not experience difficulties with broader mentalising abilities as mentalising abilities are reflected through more than verbal interaction – for instance, some parents may reflect their infants' internal states through nonverbal actions (Shai & Belsky, 2011a, 2011b).

As expected, fewer participants used non-attuned mind related comments, compared with appropriate comments. Despite this, 74% of participants used non-attuned mind-related comments when interacting with their child, which was higher than expected, based on previous research (Meins et al., 2012; McMahon & Bernier, 2017).

There was a significant correlation between non-attuned mind-mindedness and objectively measured change in Wake After Sleep Onset, suggesting that a significant increase in the disruption of mothers' sleep after the birth of their child, is associated with higher proportions of non-attuned mind-mindedness. Similarly, there was a trend for shorter total sleep time being associated with non-appropriate mind-mindedness. Both short TST and increased waking during the night is indicative of poorer sleep (Shrivastava et al., 2014). Therefore, objectively measured changes in sleep are consistent with poorer sleep being associated with higher scores in non-attuned mind-mindedness. Taken as a whole, this suggests that better sleep could be associated with lower levels of non-attuned mind-mindedness. These findings are somewhat consistent with the research of mind-mindedness in mothers with severe mental illnesses (Bigelow et al., 2018; Marcoux et al., 2017; Pawlby et al., 2010; Schacht et al., 2017).

Poorer subjectively reported sleep showed some evidence of relating to fewer non-attuned mind-mindedness. These data run contrary to hypotheses and are thus hard to interpret.

A proportion (0.07%) of the sample reported being from a non-British sample. It is known that cultural factors influence how people interact with their children (Hughes et al., 2017) alongside sleeping habits (Airhihenbuwa et al., 2016; Owens, 2004; Parsons et al., 2023). As such, it is not unreasonable to hypothesise that such factors could influence these results. Additionally, three participants reported that English was not their first language. As mind-mindedness is measured through language use, it is possible that mothers less familiar with the English language may either fall back on their native language to communicate with the child, which is unable to be coded, or rely more on nonverbal action (Shai & Belsky, 2011a, 2011b). Due to the limited sample size, it was not within the scope of this study to explore the influence of different cultures or languages.

Implications for Clinical Practice

The association between mind-mindedness and sleep could have real world implications for the assessment and treatment on mother and baby units. Knowing that a significant change in Wake after Sleep Onset and Sleep Efficiency could be associated with higher proportions of non-attuned mind-mindedness, such evidence gives thought to the environment such as light and noise levels as well as the timings for potential interventions and consultations with staff. Furthermore, consideration should be given as to how we can support single parents or parents without sufficient support networks to ensure they are having sufficient quality and quantity of sleep so as not to impact their relationship with their child. Additionally, it highlights the need to consider the implications for shift and night workers, especially the timings of appointments and calls when they are accessing services.

Limitations, and considerations for future research

The aim of this study was to provide preliminary data on the association between sleep and mind-mindedness in new mothers. Due to the Covid 19 pandemic, this study was conducted remotely, and the final sample was a smaller data set than originally targeted. This section highlights considerations drawn from the findings, in addition to highlighting some of the challenges of conducting the research.

Recruitment

This study recruited through social media over a 12-month period. Thirty-five participants consented to take part in the study. An attrition rate of 14% meant 30 new mothers participated in the study. Reasons for attrition included a sample of consenting participants

becoming ineligible, due to giving birth prior to taking part in the study; this was due to equipment not being available. A further five participants withdrew at T2, the majority citing difficulties in adapting to their new circumstances. The longitudinal design allowed for the collection of sleep data reflecting changes in the various sleep elements, as indicated by the literature. However, this may have come at a cost of the number of participants completing the study. A cross sectional design could have allowed the researcher to focus on recruitment postnatally, in addition to potentially being more proactive in resolving missing data, with both aspects likely to influence the total number of participants completing the study. Additionally, such a design would reduce the demand on mothers, potentially influencing recruitment. Firstly, future research may want to consider resource availability or advertising to mothers earlier in pregnancy. Conversely, testing at a later period may allow mothers more time to adjust to their new situation thatmay encourage less attrition during the second testing period. Secondly, changes to the study design could be considered.

Diversity and Accessibility

Adoptive mothers were eligible for the study, however none presented. Future studies may consider encouraging the recruitment of clinical populations to increase the diversity of population samples and populations researched.

Additionally, the majority of the participants were white British and English speaking. Due to the limited variability in the current sample, exploring the impact of such differences on the relationship between sleep and mind-mindedness, or specific elements of the study such as attrition, were not possible. Furthermore, the decision was made to not collect data on the mother's relationship status, living situation, support network or decision to breastfeed, due to the demand already being asked of the participants. However, such variables are known to

influence sleep routines, environments, co-sleeping habits and social support (Airhihenbuwa et al., 2016; Owens, 2004; Parsons et al., 2023; Smith & Forrester, 2021) as well as how mothers interact with their child (Hughes et al., 2017; McMahon & Bernier, 2017; Van IJzendoorn & Kroonenberg, 1988). Despite this decision, the sample size would not have allowed for any in depth analysis of these variables. As such, future research may wish to consider the inclusion of some or all of these variables to explore how they may influence the relationship between sleep and mind-mindedness. Additionally, future studies must consider how accessible such research is to a range of different cultures, in order to present data that is representative of the target population and explore the impact on the relationship discussed. This lack of diversity appears to be part of a broader issue within research, in which very few studies have reported on cultural differences or looked after children (McMahon & Bernier, 2017).

Use of Oura rings and Actiwatches

Firstly, the decision to use Oura rings was reflected in evidence of good concordance with other forms of actigraphy, alongside the ease of wearing by parents of small babies (Asgari Mehrabadi et al., 2020; Parsons et al., 2023). However, a limitation of their use was that some rings were returned with no data on them. It was speculated that perhaps the rings were not frequently or sufficiently charged prior or during their testing period, and that during the process of their return a 'hard reset' took place. This 'hard reset' can occur when Oura rings are placed on their charger and knocked with force. Future research needs to be aware of these limitations and consider protecting devices to reduce data loss. Secondly, numerous actiwatches were returned with no data, resulting in only partial data being collected. It was hypothesised that due to Covid 19 and the subsequent postal strikes, devices were reaching

participants outside of the configured window. Steps were taken to mitigate missing data such as agreeing start dates with participants prior to sending out devices and liaising with participants during postal strikes, at times requiring sending out a second device special delivery. Additionally, researchers checked devices for data within days of their return to reduce chances of device malfunctioning. The findings suggest that such recording measures were feasible for mothers, however, the high proportion of partial or missing data highlights the need for careful consideration when conducting future research.

Mind-mindedness observation

The mind-mindedness observations were administered over Zoom video conferencing. This approach was adapted from the Meins and Fernyhough Mind-mindedness Manual (2015), that allowed the research team to be flexible in organising times to meet with the participants. It is believed that this reduced the burden of the task on participants and is a consideration for future research. However, this did come at the cost to the data collected, with challenges including slow internet, technical difficulties and sound issues.

Additionally, cultural differences should be considered when measuring mind-mindedness. Hughes et al. (2017) found parents from Hong Kong to have lower mind-mindedness, compared with their British counterparts. Additionally, collectivist cultures may demonstrate a difference in mind-mindedness (Keller, 2012; McMahon & Bernier, 2017).

Conclusion

This study demonstrated some evidence of a relationship between sleep and mind-mindedness in new mothers, specifically, the relationship between non-attuned mind-mindedness and changes to sleep/wake periods. Most clearly, change in wake after sleep onset

was associated with higher proportions of non-attuned mind-mindedness. Consistent with this, was some evidence that objectively measured sleep was associated with a higher frequency of non-attuned mind-mindedness. However, there were methodological considerations that limit the conclusions drawn from the data and further research is required to fully understand the relationship between sleep and mind-mindedness. Although there were some challenges with this study, it demonstrated that such a study is feasible. Additionally, this study provides some evidence that the observational measure of mind-mindedness could be conducted remotely, or via similar communication software. Further efforts would also be needed to recruit a more diverse population.

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Public dissemination documents

How we talk to our child matters!

A meta-analysis on the relationship between mind-mindedness and attachment

Understanding both attachment and mind-mindedness constructs, can offer insight into the development of a person's cognition, language, personality and relationships. Attachment typically develops during an infant's first year, by interacting with their main caregiver. This becomes the default attachment style that can go on to influence how the child relates to oneself, others, and the world. Attachment can be categorised as one of the following four subgroups: Secure, Insecure-avoidant, Insecure-resistant, Insecure-disorganised. An important element of this developing relationship is a parent's ability to be aware and respond appropriately to a child's needs. Mind-mindedness relates to a person's ability to spontaneously tune into another's emotions, preferences and the like. How this is used to inform the following interactions with the person is broken down into attuned and non-attuned categories. This construct has, so far, predominantly been measured observing mother-child interactions.

Many studies have found a relationship between mind-mindedness and attachment, with maternal mind-mindedness explaining approximately 6.5-12.7% of the variation in attachment styles. Given the knock-on effect these two constructs have on how we develop and navigate the world, it feels important to have a full and comprehensive understanding of this relationship. However, there is currently no meta-analysis purely focusing on how these two concepts interact.

This current meta-analysis aimed to collate the existing research on mind-mindedness and attachment. Data was compiled from 31 studies from across the world, that measured the relationship between these two constructs, predominantly within the biological parent-child relationship. As previous research has reported, the two elements of mind-mindedness relate differently to attachment security and therefore the analyses have been broken down into these two subcategories.

The findings showed that more attuned mind-mindedness were likely to be associated with a more secure attachment style. Conversely, non-attuned mind-mindedness have been shown to be associated with more insecure attachment styles. Neither category of mind-mindedness was able to differentiate between insecure subgroups: Insecure-avoidant, Insecure-resistant, Insecure-disorganised.

Analysis showed that assessment measures for either mind-mindedness or attachment did not influence the results. Due to differences in reporting the relationship between mind-mindedness and attachment among mothers and fathers, was the only other variable that could be explored. Although there was a trend towards a difference between mothers and fathers, only 3 studies with fathers were included in the analysis. More studies involving fathers would be needed, to make a more robust conclusion about this trend.

The literature reviewed shows a clear relationship between mind-mindedness and attachment. The nuance of this relationship requires further exploration. Specifically, it was found that more research conducted with fathers and non-biological parents would be a helpful contribution to the literature. Additionally, factors that could influence the mind-mindedness and attachment relationship, such as Socio-Economic Status, age and mental health, would benefit from being explored.

Sleep is linked with how we talk to our children.

A research study on the relationship between sleep and mind-mindedness in new mothers

Sleep affects our mood, ability to manage stress and our brain's ability to process information. These processes include recognising and appropriately interpreting others' internal states such as their emotions, possible thoughts and processes. This tendency to understand infants as driven by their internal mental states, is known as 'mind-mindedness'. Given the tendency for new mothers to experience significant sleep changes, it is important to explore if such sleep changes are associated with new mothers' ability to interact with their child, as if they have a mind of their own. Parental mind-mindedness has been linked to their child's social, emotional and language development. It has also been able to make predictions on parent-child attachment. The concept of mind-mindedness is identified by two categories of comments made by mothers, 'appropriate' and 'non-attuned'. Appropriate mind-mindedness refers to a mother's ability to recognise and interpret their infant's current internal states. Non-attuned mind-mindedness is when a mother's comments about her child's internal states appear at odds with the child's current experiences. For example, saying "you like that" when the child is crying.

Mothers who were expecting their first child recorded their sleep over a 7-day period, during their third trimester, using an actigraphy device and by keeping a sleep diary. This was repeated approximately three months after the birth of their child. When their baby was approximately three months old, mother and baby took part in a play session to measure maternal mind-mindedness.

Results showed new mothers experienced some changes in sleep between these two time points. Specifically, Wake After Sleep Onset and Sleep Efficiency which indicated that mothers had a more disrupted night's sleep after the birth of their child. There appeared to be no relationship between mothers' sleep and appropriate mind-mindedness. However, non-attuned mind-mindedness appeared to increase as mothers spent more time awake during the night and therefore had more disrupted sleep. Broadly, poorer sleep was associated with non-attuned mind-mindedness.

This study provided the first insights into the relationship between sleep and mind-mindedness in new mothers. Evidence showed that more time spent awake after initially going to sleep was associated with more non-attuned mind-mindedness. However, further research is needed to explore factors that could influence the relationship between sleep and mind-mindedness, such as culture and Socio-Economic Status.

Appendices

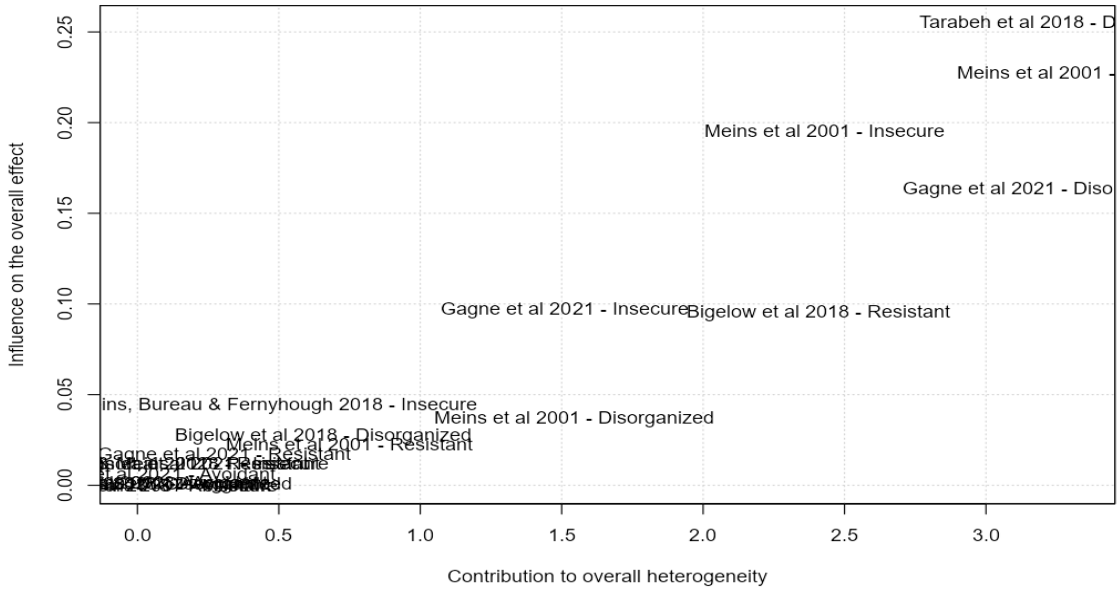
Appendix A.

Description of study level effects of group level data for appropriate mind-mindedness and attachment security.

Study	Attachment Style	Effect	Std.Er	Confidence Interval (Lower)	Confidence Interval (Upper)	Weight (fixed)	Weight (random)	N	Attachment measure	MM Measure
Arnott & Meins 2007	Insecure	0.52	0.51	-0.47	1.52	3.9	2.6	28	SS	Free Play
Bigelow et al 2018	Resistant	-0.31	0.35	-0.99	0.37	8.3	4.0	40	SS	Free Play
Bigelow et al 2018	Disorganized	0.87	0.36	0.17	1.57	7.8	3.9	40	SS	Free Play
Crugnola et al 2021	Insecure	0.22	0.39	-0.55	0.99	6.5	3.5	29	AAI	Free Play
Gagne et al 2021	Insecure	-0.05	0.20	-0.45	0.35	24	5.9	96	SS	Free Play
Gagne et al 2021	Avoidant	0.35	0.31	-0.25	0.95	10.7	4.5	62	SS	Free Play
Gagne et al 2021	Resistant	0.18	0.36	-0.53	0.89	7.6	3.8	57	SS	Free Play
Gagne et al 2021	Disorganized	-0.32	0.25	-0.80	0.17	16.3	5.3	73	SS	Free Play
Meins, Bureau & Fernyhough 2018	Insecure	0.20	0.12	-0.03	0.43	72.1	7	165	SS	Free Play
Meins et al 2012	Avoidant	0.44	0.19	0.08	0.82	28.1	6.1	174	SS	Free Play
Meins et al 2012	Resistant	0.26	0.31	-0.35	0.88	10.2	4.4	149	SS	Free Play
Meins et al 2012	Disorganized	0.51	0.25	0.03	0.99	16.5	5.3	157	SS	Free Play
Shai & Meins 2018	Avoidant	0.45	0.19	0.08	0.82	28	6.1	173	SS	Free Play
Shai & Meins 2018	Resistant	0.26	0.31	-0.35	0.88	10.2	4.4	148	SS	Free Play
Shai & Meins 2018	Disorganized	0.51	0.25	0.03	0.99	16.5	5.3	156	SS	Free Play
Meins et al 2001	Insecure	1.18	0.29	0.61	1.74	12.1	4.7	65	SS	Free Play
Meins et al 2001	Avoidant	1.37	0.35	0.69	2.06	8.2	4.0	57	SS	Free Play
Meins et al 2001	Resistant	0.98	0.48	0.04	1.92	4.3	2.8	50	SS	Free Play
Meins et al 2001	Disorganized	1.34	0.61	0.14	2.54	2.7	2.0	48	SS	Free Play
Tarabeh et al 2018	Resistant	0.49	0.34	-0.17	1.15	8.8	4.1	60	SS	Free Play
Tarabeh et al 2018	Disorganized	1.34	0.33	0.70	1.98	9.4	4.3	63	SS	Free Play

Appendix B.

Baujat diagnostic plot of sources of heterogeneity to identify the impact of influential primary studies for appropriate mind-mindedness and attachment security.



Note. The vertical axis reports the influence of the study on the overall effect and the horizontal axis reports the discrepancy of the study with the rest of the literature.

The result of this "leave-one-out" analysis is presented on the Baujat plot (Baujat et al., 2002) indicate that Tarabet et al. (2018), Meins et al. (2001) and Gagne et al. (2021) were influential on the overall meta-analytic synthesis and were most discrepant from the average reported effect. The random effects model was recalculated with the 3 studies removed. The corrected random effects model reported a synthesis of SMD = 0.43 (95% CI 0.26 to 0.61). The corrected random effects model evidences an approximately 11.5% decrease relative to the uncorrected estimate and heterogeneity was reduced to a Higgins i^2 =33%. However, it should be noted that the corrected and uncorrected models were both statistically significant and there is no substantive change in the conclusions resulting from the emission of these three discrepant studies. The three studies were reviewed as no such risk of bias was identified these studies were retained for subsequent analysis.

Appendix C.

Description of study level effects of group level data for non-attuned mind-mindedness and attachment.

Study	Attachment Style	Effect	Std.Er	Confidence Interval (Lower)	Confidence Interval (Upper)	Weight (fixed)	Weight (random)	N	Attachment measure	MM Measure
Arnot & Meins 2007	Insecure	-0.99	0.53	-2.03	0.04	3.6	1.4	28	SS	Free Play
Bigelow et al 2018	Disorganized	-0.84	0.36	-1.54	-0.14	7.8	1.8	40	SS	Free Play
Bigelow et al 2018	Resistant	-0.05	0.35	-0.73	0.62	8.4	1.9	40	SS	Free Play
Crugnola et al 2021	Insecure	0	0.39	-0.77	0.77	6.6	1.7	29	AAI	Free Play
Gagne, Lemlin & Tarabulsy 2021	Avoidant	0.23	0.30	-0.37	0.83	10.8	2.0	96	SS	Free Play
Gagne, Lemlin & Tarabulsy 2021	Disorganized	-0.15	0.25	-0.64	0.33	16.4	2.1	62	SS	Free Play
Gagne, Lemlin & Tarabulsy 2021	Insecure	0.07	0.20	-0.33	0.47	24.0	2.2	57	SS	Free Play
Gagne, Lemlin & Tarabulsy 2021	Resistant	0.43	0.37	-0.28	1.15	7.5	1.8	73	SS	Free Play
Meins et al 2012	Avoidant	-0.77	0.19	-1.15	-0.40	27.2	2.2	174	SS	Free Play
Meins et al 2012	Disorganized	-0.77	0.25	-1.26	-0.28	16.2	2.1	149	SS	Free Play
Meins et al 2012	Resistant	-2.08	0.34	-2.74	-1.42	8.9	1.9	157	SS	Free Play
Meins, Bureau & Fernyhough 2018	Insecure	-0.32	0.12	-0.55	-0.09	71.5	2.3	165	SS	Free Play
Shai & Meins 2018	Avoidant	-0.77	0.25	-1.26	-0.29	16.2	2.1	173	SS	Free Play
Shai & Meins 2018	Disorganized	-0.77	0.25	-1.26	-0.28	16.2	2.1	148	SS	Free Play
Shai & Meins 2018	Resistant	-2.08	0.27	-2.61	-1.55	13.6	2.0	156	SS	Free Play
Tarabeh et al 2018	Disorganized	-1.09	0.32	-1.71	-0.47	9.9	1.9	60	SS	Free Play
Tarabeh et al 2018	Resistant	-1.18	0.35	-1.88	-0.50	8.1	1.8	63	SS	Free Play

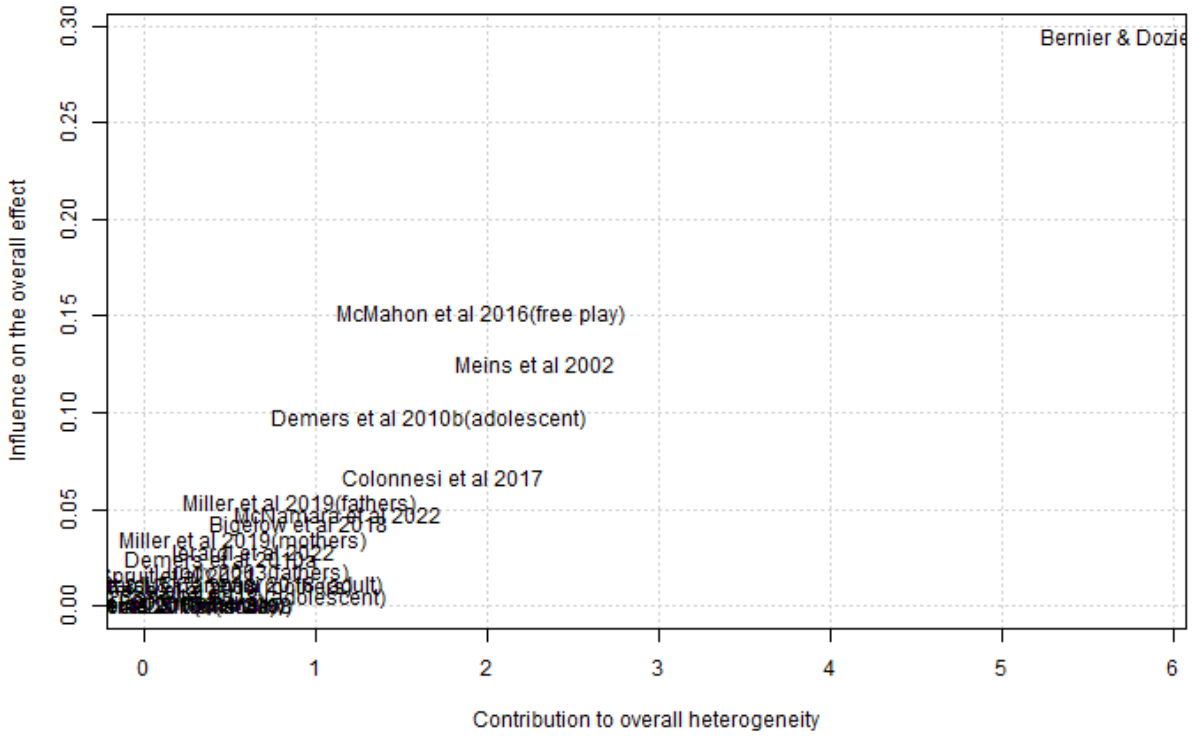
Appendix D.

Descriptives of study level effects for correlations between appropriate mind-mindedness and attachment.

Study	Effect	Std.Er	Confidence Interval (Lower)	Confidence Interval (Upper)	Weight (fixed)	Weight (random)	N	MM Measure	Attachment Measure
Arnott & Meins 2008(mothers)	-0.05	0.24	-0.51	0.41	18	12.0	28	Free Play	AAS
Arnott & Meins 2008(fathers)	0.07	0.27	-0.45	0.59	14	9.90	25	Free Play	AAS
Bernier & Dozier 2003	-0.38	0.13	-0.63	-0.13	61	21.76	64	Interview	SS
Bigelow et al 2018	-0.08	0.14	-0.36	0.20	50	20.17	87	Free Play	SS
Demers et al 2010a	0.26	0.10	0.06	0.45	103	25.46	106	Free Play	AAI
Demers et al 2010b(adolescent)	0.39	0.12	0.15	0.62	69	22.69	72	Free Play	SS
Demers et al 2010b(adult)	0.17	0.19	-0.19	0.54	29	15.61	32	Free Play	SS
Crugnola, Ierardi & Canevini 2018 (adult)	0.01	0.16	-0.31	0.33	38	17.89	41	Free Play	AAI
Crugnola, Ierardi & Canevini 2018 (adolescent)	0.06	0.16	-0.25	0.37	41	18.53	44	Free Play	AAI
Laranjo, Bernier & Meins 2008	0.15	0.15	-0.14	0.43	47	19.67	50	Free Play	AQS
Lundy 2003(mothers)	0.21	0.22	-0.22	0.63	21	12.96	24	Free Play	AQS
Lundy 2003(fathers)	0.34	0.22	-0.08	0.77	21	12.96	24	Free Play	AQS
McMahon et al 2016(free play)	-0.12	0.06	-0.24	0.00	250	29.79	150	Free Play	MFAS
McMahon et al 2016(interview)	0.15	0.06	0.027	0.28	250	29.79	132	Interview	MFAS
Reese et al 2019	0.20	0.07	0.06	0.34	201	28.95	206	Free Play	SS
Meins et al 2002	0.45	0.14	0.18	0.71	54	20.79	75	Free Play	SS
Miller et al 2019(mothers)	-0.02	0.10	-0.22	0.18	97	25.07	102	Free Play	AQS
Miller et al 2019(fathers)	0.31	0.10	0.11	0.51	97	25.07	102	Free Play	AQS
Colonnesi et al 2017	0.45	0.18	0.10	0.80	31	16.17	35	Free Play	AQS
McNamara et al 2022	0.37	0.16	0.06	0.68	40	18.32	43	Interview	MFAS
Ierardi et al 2022	-0.05	0.15	-0.34	0.24	46	19.49	98	Free Play	AAI

Appendix E.

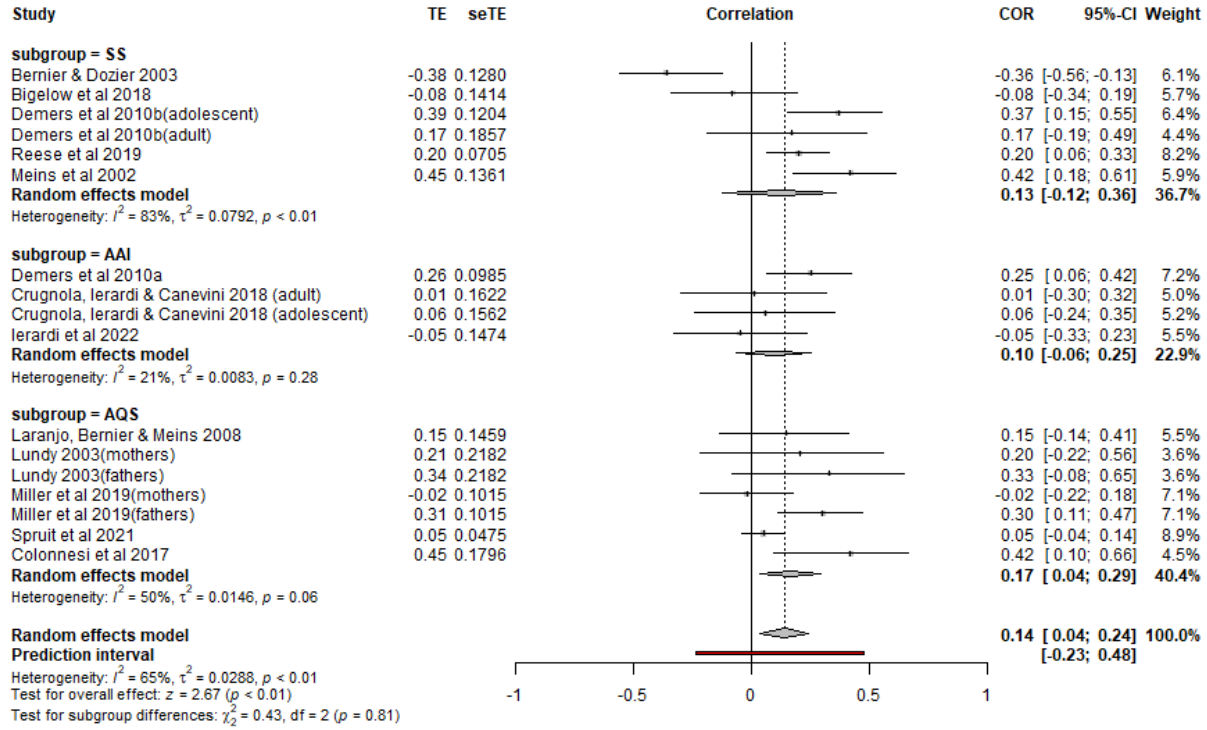
Baujat diagnostic plot of sources of heterogeneity to identify the impact of influential primary studies for correlations between appropriate mind-mindedness and attachment security.



The result of this "leave-one-out" analysis presented on the Baujat plot (Baujat, Pignon, & Hill, 2002) identified the study by Bernier and Dozier (2003) as influential on the overall synthesis and discrepant from the other studies included in this analysis. The random effects model was recalculated with the Bernier and Dozier (2003) removed. The corrected random effects model reported a synthesis of r = 0.13 (95% CI 0.04 to 0.21). The corrected random effects model did not change any of the substantive conclusions of this meta-analysis. Accordingly, the study by Bernier and Dozier (2003) was retained in subsequent analysis.

Appendix F.

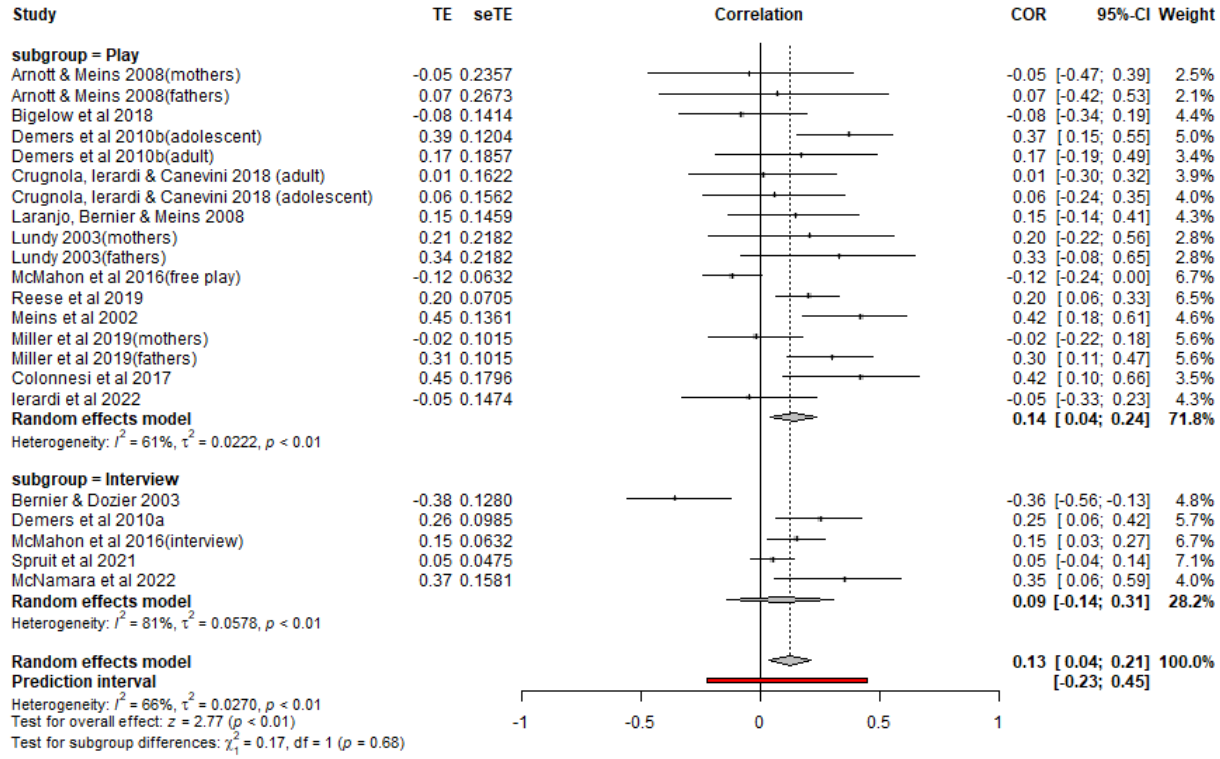
Subgroup analysis of measures used to assess attachment in appropriate mind-mindedness and attachment relationship.



Note. A positive value indicates higher values for the secure attachment style, and negative values indicates higher values of insecure attachment style.

Appendix G.

Subgroup analysis of measures used to assess mind-mindedness in appropriate mind-mindedness and attachment relationship.



Note. A positive value indicates higher values for the secure attachment style, and negative values indicates higher values of insecure attachment style.

Appendix H.

Descriptives of study level effects for correlations between non-attuned mind-mindedness and attachment.

Study	Effect	Std.Er	Confidence Interval (Lower)	Confidence Interval (Upper)	Weight (fixed)	Weight (random)	N	MM Measure	Attachment Measure
Arnott & Meins 2008 (mothers)	-0.31	0.24	-0.77	0.15	18	11.83	28	Play	AAS
Arnott & Meins 2008 (fathers)	-0.17	0.27	-0.70	0.35	14	9.96	25	Play	AAS
Bigelow et al 2018	0.18	0.14	-0.10	0.46	50	19.3	87	Play	SS
Crugnola, Ierardi & Canevini 2018 (adult)	0.09	0.16	-0.23	0.41	38	17.2	41	Play	AAI
Crugnola, Ierardi & Canevini 2018 (adolescent)	0.01	0.16	-0.29	0.32	41	17.8	44	Play	AAI
Irerardi et al 2022	-0.14	0.10	-0.34	0.06	95	23.7	98	Play	AAI
McMahon et al 2016 (7 months)	-0.21	0.06	-0.33	-0.09	250	28..0	150	Play	MFAS
McMahon et al 2016 (19 months)	-0.08	0.06	-0.20	0.04	250	28	132	Interview	MFAS
Meins et al 2002	-0.60	0.14	-0.87	-0.34	54	19.9	75	Play	SS
Miller et al 2019 (mothers)	0.07	0.10	-0.13	0.27	97	23.8	101	Play	AQS
Miller et al 2019 (fathers)	0.10	0.10	-0.10	0.30	97	23.8	101	Play	AQS

Appendix I.

ACTiware Cleaning Protocol

UNIVERSITY OF BIRMINGHAM

Actigraphy Cleaning Protocol VERSION 2

Cerebra Network for Neurodevelopmental Disorders

School of Psychology

University of Birmingham

The purpose of this protocol is to remove the artefact associated with using activity as a proxy measure of sleep. Wherever possible, the intention is to keep the actigraphy data unchanged. However, where changes are necessary, the principles underpinning the nine steps can be applied to clean the data in a variety of situations. The three key principles of actigraphy cleaning are:


The exclusion principle (steps 1, 2, 3, 7)


The epochs principle (steps 4, 5, 6)


The congruence principle (steps 8, 9)

Cleaning Actiwatch Data

Materials needed to clean data:

1) Philips Actiware output
2) Child's sleep information (collected from paper sleep diary or mobile app diary).

The following pages include 9 steps to remove artefact from Actiware sleep data. These steps may or may not be applicable to each participant's data and need only be used when relevant (see corresponding worked examples). **Please keep records of your decision making using a 'cleaning log' on RDS.**

For clarity, the following definitions are used throughout:

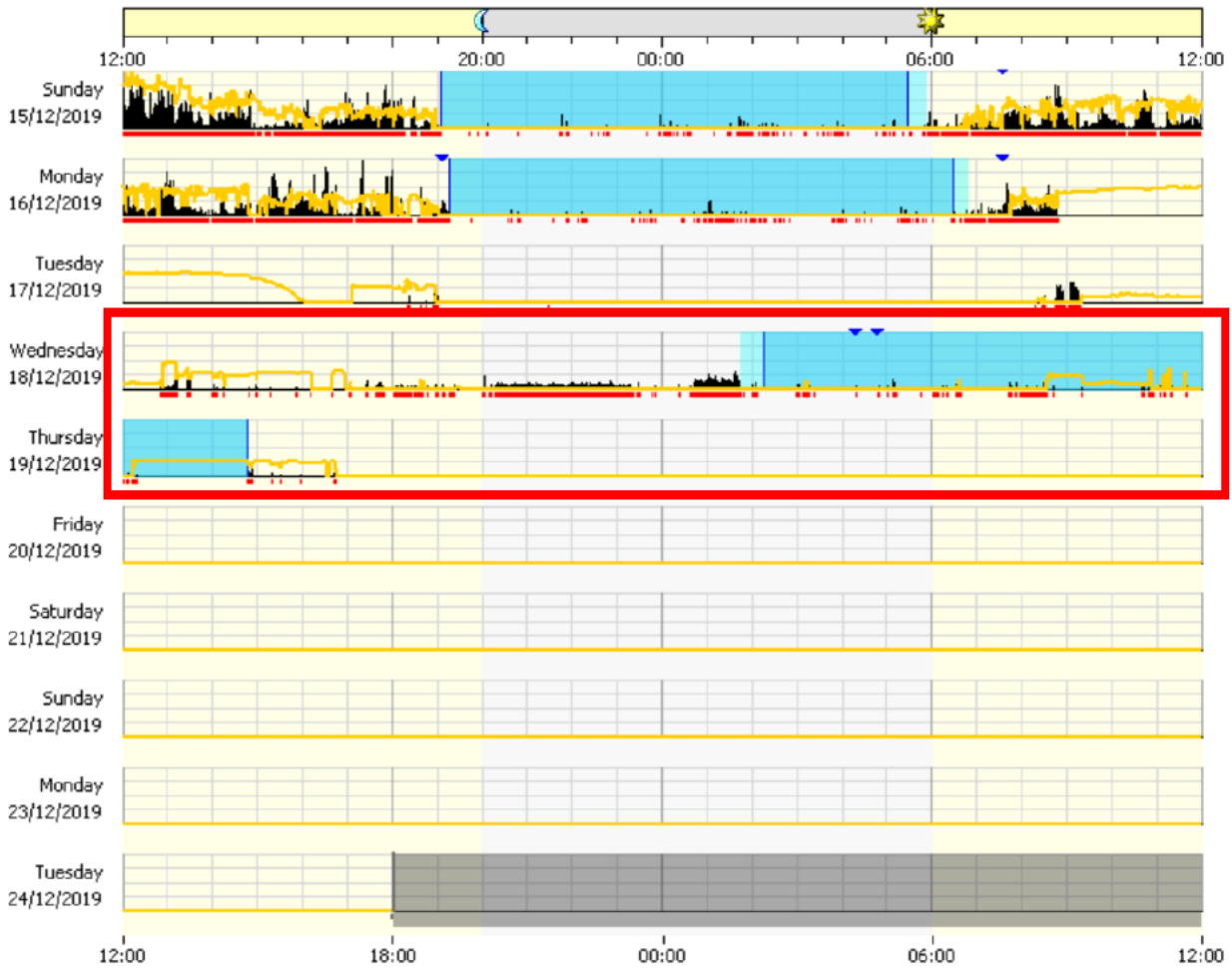
- Actogram – This is a visual representation of the participant's sleep/wake across the data collection period as a whole.
- Automatically calculated sleep interval – This is the period of time automatically calculated within Actiware, in which the participant is assumed to be asleep. It appears as a rest interval within Actiware, and is indicated by sky blue shading.
- Lights out time – The time that the child is put to bed and the light turned off, ready to sleep (indicated by sleep diary or mobile app diary information).
- Sedentary activity – This refers to activities such as reading, or watching TV where the child is not moving much and thus may be interpreted as asleep. Periods of sedentary activity will be noted by the caregiver in the sleep diary or mobile app diary.
- Event marker – The event marker is a button on the actiwatch that the caregiver/child has been instructed to press to indicate the time of 'lights out' and 'get up'. It appears on the actogram as a dark blue triangle.

In order to follow these steps you will need to have the participant's Actiware sleep data (actogram) and diary data for the corresponding study period. Each night of actigraphy data is only eligible to be cleaned if there is corresponding diary data for that night. This need not be complete (i.e. does not need to include bed time, light out time, wake up time, get up time and all wakings – but at least one of these is necessary for the data to be cleaned). On the rare occasion that there is no diary data for a given night, but the event marker has been used appropriately (either according to the parent in the diary or confirmed by a member of the research team with the parent after the study period), the event marker may be used to indicate lights out and wake up time. If there is no diary data and no reliable event marker for a given night, this night should be excluded from the study period.

Step 1

Exclude any nights which appear on actogram that occur before or after data collection according to diary information (i.e. when actiwatch was in transit, if data collection was delayed).

a) First click the automatically calculated sleep interval that has erroneously been created before or after the sleep assessment dates, and click 'delete' (if applicable).
b) Enter exclusion interval(s) for days before and/or after data collection, when the watch was in transit or not worn by the child (Interval → Add interval → Interval type: excluded). Exclude whole non-assessment day (from 12:00 – 12:00), even if there are black activity lines.



In the example above, a) delete automatically calculated sleep interval; b) enter exclusion interval from 12:00 (17/12/2019) to point at which watch stopped collecting data = 18:00 (24/12/2019).

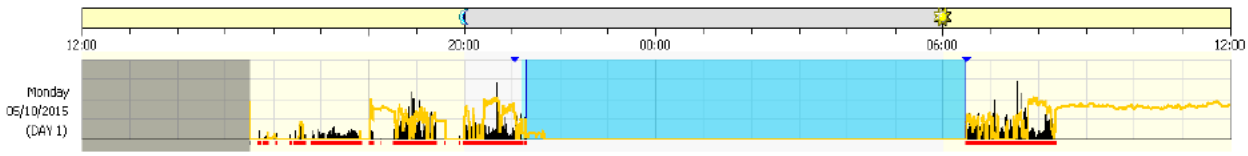
Step 2

Check overlap between actiwatch removal times and "time lights turned off" in the child's sleep diary. Exclude any sleep intervals where the caregiver identifies that the watch has been taken off/removed for a **large proportion of the night (2 hours or more)**. Short actiwatch removals that overlap with the start time of the automatically calculated sleep interval (e.g. 20 minute watch removal during bath time) are not adjusted here (see Step 8).

a. If actiwatch removal is identified, check whether actiwatch removal occurs within the reported sleep period (i.e. between sleep diary lights out and wake up time). If actiwatch removal occurs before the automatically calculated sleep interval, adjustments are not to be made.
b. If any removal times are identified within the reported sleep period, check times against actogram for consistency by visually inspecting the specific night in question (i.e. no black lines of activity at this time).
c. In Actiware, examine the night in question systematically. Click on the automatically calculated sleep interval for that night, and use the > key to scroll through the sleep interval. Examine the 'ac =' counter. If ac = 0 occurs continuously for a period of 2 hours or more between diary lights out and wake up time (check against time epochs when scrolling), exclude this 24 hour period. First delete this sleep interval, then enter exclusion period from 12:00 – 12:00 (Interval → Add interval → Interval type: excluded).
d. If parent reports that the actiwatch has been removed, but this is not evident on the actogram (i.e. evidence of movement and activity during this time, ac = 0 does not occur continuously for a period of 2 hours or more), keep the existing sleep interval as it is and continue to Step 3.

Monday 5th	To be completed in the evening			
Time and duration of any daytime naps	Nap 1	Nap 2	Nap 3	
Timings and durations of activities in the evening when child sedate and not moving (e.g. watching TV or reading)				
Time got into bed	8.55pm			
Time lights turned off	9.00pm			

Tuesday 6th	To be completed throughout the day	by (initials)
Time Actiwatch removed	Child would not wear watch last night – removed at 9.15pm	
Time Actiwatch replaced	Replaced around 6.30am	
Time Actiwatch removed		
Time Actiwatch replaced		
Time Actiwatch removed		
Time Actiwatch replaced		



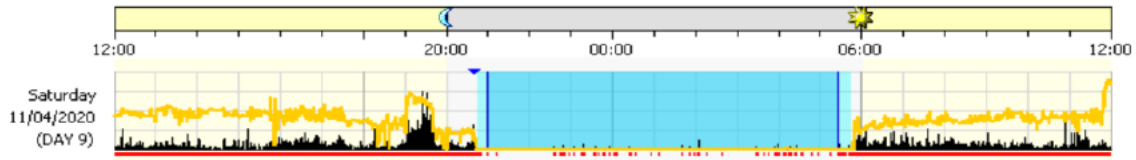
Parent reported that the actiwatch was removed during the night of Monday 5th. This occurred within the sleep period reported in the sleep diary. The actogram supports this information as there was no evidence of activity during this night. This is consistent with parent report. Therefore, data should be excluded for Monday .

Saturday 11th

To be completed in the evening			
Time and duration of any daytime naps	Nap 1	Nap 2	Nap 3
Timings and durations of activities in the evening when child sedate and not moving (e.g. watching TV or reading)			
Time got into bed	8.45pm		
Time lights turned off	8.50pm		

Sunday 12th

To be completed throughout the day	by (initials)
Time Actiwatch removed	Think watch was taken off last night – wasn't wearing at breakfast
Time Actiwatch replaced	
Time Actiwatch removed	
Time Actiwatch replaced	
Time Actiwatch removed	
Time Actiwatch replaced	



Parent reported that the actiwatch was removed during the night of Saturday 11th. This occurred within the sleep period reported in the sleep diary. The actogram does not support this information as there was activity during this night. This is inconsistent with parent report. Therefore, this interval ***should not*** *be excluded within this step.*

Step 3

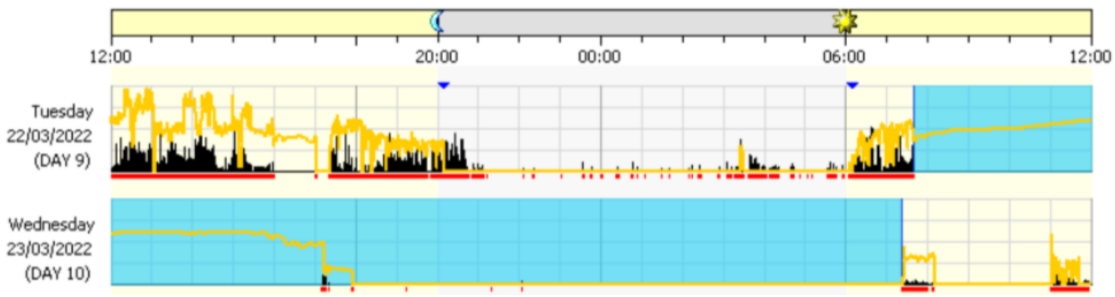
Exclude any nights where the actiwatch appears to have been taken off but this **was not** noted in the sleep diary information.

a. Initially, visually inspect the **entire actogram** at a glance and identify any overnight periods with continuous intervals where no black lines are present.
b. If any periods are identified, check whether these 'inactive' periods are within the reported sleep period (i.e. between sleep diary lights out and wake up time). If 'inactivity' occurs before the automatically calculated sleep interval, adjustments are not to be made in this step.
c. If 'inactive' periods are identified within the reported sleep period, examine the night in question systematically. Click on the automatically calculated sleep interval for that night, and use the > key to scroll through the sleep interval. Examine the 'ac =' counter. If ac = 0 occurs continuously for a period of 2 hours or more between diary lights out and wake up time (check against time epochs when scrolling), exclude this 24 hour period. First delete this sleep interval, then enter exclusion period from 12:00 – 12:00 (Interval → Add interval → Interval type: excluded).
d. If inactivity is suspected, but this is not evident on the actogram (i.e. evidence of movement and activity during this time, ac = 0 does not occur continuously for a period of 2 hours or more), keep the existing sleep interval as it is and continue to Step 4.

The parent did not report removal of the watch during the night of Monday 21st, but through visually inspecting the actogram, and systematically examining the activity count data, over 7 hours of inactivity (ac = 0) was confirmed (see section in red). As there is an inactive period of over 2 hours, this automatically calculated sleep interval would be deleted and replaced with an exclusion interval.

Step 4

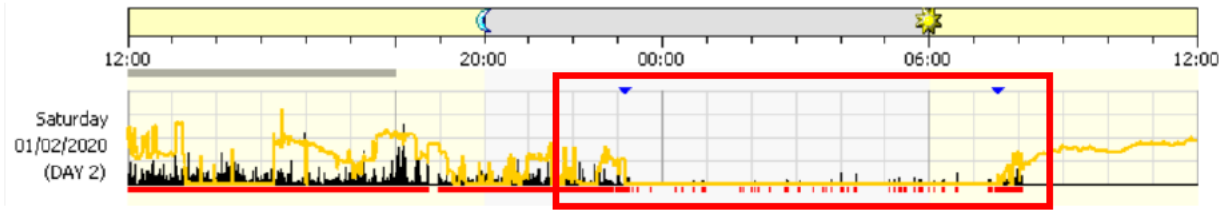
Insert sleep intervals that are missing overnight. Use this step to correct any automatically calculated sleep intervals that are erroneously created **only within the daytime** or to insert sleep interval where **no data has automatically been calculated** (usually occurs when the watch has been removed for an extended period in the day, making it difficult to distinguish between sleep and wake). Please note, you can still follow this step if sleep diary information is missing following the epochs principle if necessary.



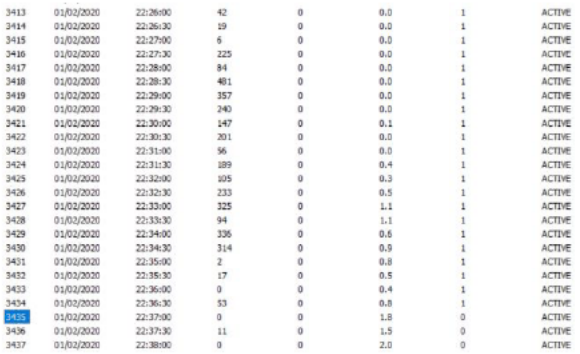
The sleep interval is missing for the night of Tuesday 22nd but has been created in they daytime, due to an extended actiwatch removal on Wednesday 23rd. Erroneous daytime automatically calculated sleep interval is to be deleted, and interval is to be inserted overnight following the epochs principle.

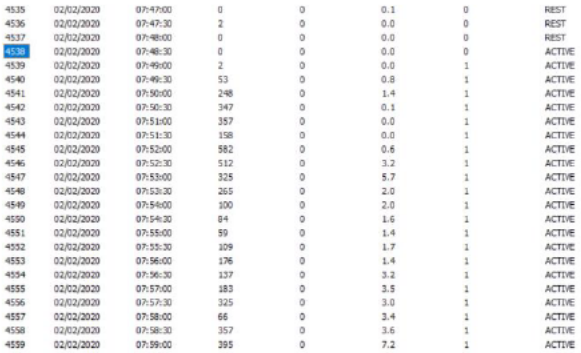
a. Note any occasions where sleep has erroneously been created in the daytime/sleep intervals are missing.
b. Check whether the erroneous daytime automatically calculated sleep interval both starts and ends outside of the sleep diary reported times. If so, proceed with this step following (c) below. If the sleep period start time overlaps with the start time according to the sleep diary information, do not adjust here (adjust in Step 6).
c. Creating a new sleep interval:

- Delete the erroneous daytime automatically calculated sleep interval (if applicable).
- To find the start time, use the data list function (View → Data List) to find the first 40 epochs coded as **0 in the sleep/wake column** after "time lights out" in child's sleep diary. From here, go back to the last 20 epochs coded as **1 in the sleep/wake column** in the data list. The new start time is the first 0 after the 20 epochs coded as **1 in the sleep/wake column**.
- To find end time, use the data list to find the last 40 epochs coded as **0 in the sleep/wake column** before wake up time in child's sleep diary. From here, go forward to the first 20 epochs coded as **1 in the sleep/wake column** in the data list. The new end time is the last 0 before the 20 epochs coded as **1 in the sleep/wake column**.



Parent reports sleep period from 23.10pm to 07.22am. This has not been captured in the actogram, so a sleep interval needs to be created. 40 epochs coded as 0 closest to 23.10pm are located in the data list (start of 40 epochs at 00:59:00). From here 20 epochs coded as 1 before this time are located. First 0 after this sequence is recorded to indicate new start time of sleep interval = 22:37:00. 40 epochs coded as 0 closest to 07.22am are located in the data list (end of 40 epochs at 07:19:30). From here 20 epochs coded as 1 after this time are located. Last 0 before this sequence is recorded to indicate new end time of sleep interval = 07:48:30. See corresponding data lists below for clarification. PLEASE NOTE – this may not be the final sleep interval for this night, and these times may change according to principles implemented in later steps (i.e Step 9).





Start time of sleep interval = 22:37:00

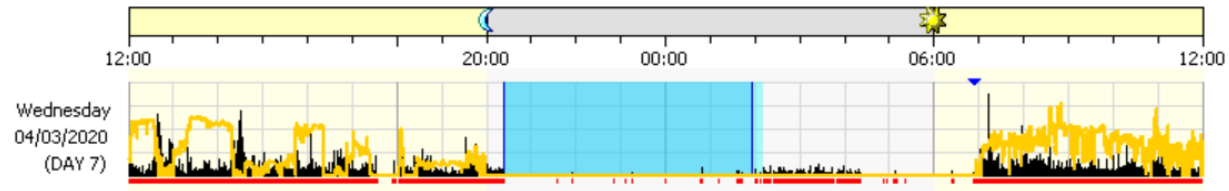
End time of sleep interval = 07:48:30

Step 5

Extend sleep intervals that have not captured the whole night reported in the sleep diary. To do this, use the data list to look for 40 epochs coded as **0 in sleep/wake column**, that have not been included within the automatically calculated sleep interval, but occur between lights out and wake up time in child's sleep diary. Please note, you can still follow this step if sleep diary information is missing following the epochs principle if necessary.

- WAKE UP TIME APPEARS 'TOO EARLY': If 40 epochs coded as **0 in sleep/wake column** are *after* the automatically coded sleep interval, look ahead for 20 epochs coded as **1 in sleep/wake column** and extend the sleep interval to last epoch coded as 0 before the 20 epochs coded as 1. When adjusting the sleep interval here, keep the original start time of the automatically calculated sleep interval.
- START OF SLEEP TIME APPEARS 'TOO LATE': If 40 epochs coded as **0 in sleep/wake column** are *before* the automatically coded sleep interval, look back to last 20 epochs coded as **1 in sleep/wake column** and extend interval to first epoch

coded as 0 in sleep/wake column after the 20 epochs coded as 1. When adjusting the sleep interval here, keep the original end time of the automatically calculated sleep interval.



Parent reports sleep period as 19.56pm to 06.56am. The automatically calculated sleep interval as appeared to calculate the wake up time as being 'too early'. Here, 40 epochs coded as 0 are identified in the data list between the automatically coded end time (02:11:00), and the reported wake up time of 06:56:00. Looking ahead, 20 epochs coded as 1 are found. Last 0 before this sequence is recorded to indicate new end time of sleep interval = 06:52:00. Start time of sleep interval remains the same (20:24:00). PLEASE NOTE – this may not be the final sleep interval for this night, and these times may change according to principles implemented in later steps (i.e Step 9).

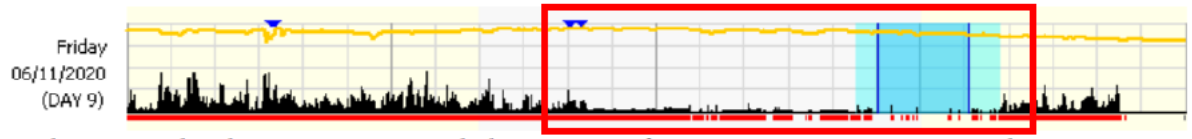
a. If automatically coded sleep interval looks short, but there are significant periods of late morning activity that indicates (1) waking, (2) waking activity and then (3) extended low activity – the child may have had a late morning nap after their first waking. Refer to information reported about naps/wakings within the sleep diary information. If parent reports a morning nap of more than 2 hours after a significant period of waking of more than 2 hours, you may wish to indicate two separate sleep intervals using the epochs principle **FOR THE PURPOSES OF THE FEEDBACK REPORT ONLY**.

   The interval would not be extended within this step to incorporate the late morning nap as part of the actigraphy you would use for data analysis.

*In this example, the parent reports a morning nap of more than 2 hours after a significant period of waking of more than 2 hours. This is adjusted to indicate two separate sleep intervals using the epochs principle **FOR THE PURPOSES OF THE FEEDBACK***

***REPORT ONLY**. The actigraphy used for the purposes of data analysis would not adjust/extend the automatically calculated sleep interval here.*

b. In some instances (due to a technical fault with older watches) the automatically calculated sleep interval may need to be extended, but this is not possible. If there are low level constant periods of activity that make it difficult to extend the sleep interval (40 epochs coded as **0 in the sleep/wake column** before or after sleep period reported in the child's sleep diary cannot be found) THIS DAY MUST BE EXCLUDED. Exclusion interval would be inserted from 12:00 to 12:00 for the entire day.



In this example, the parent reported sleep time is from 20.45pm to 07.30am. The automatically calculated sleep interval has appeared to calculate the start of sleep time as being 'too late' and the sleep interval start time would be adjusted according to the epochs principle. However, there are constant periods of low level activity, which means 40 epochs of 0 between 20:45:00 and 04:32:30 cannot be found to adjust the sleep interval start time. Therefore, this assessment day must be excluded (12:00 to 12:00).

If this error is observed: a) do not send out this watch again for data collection with another family, b) report this faulty watch immediately to the Principal Investigator.

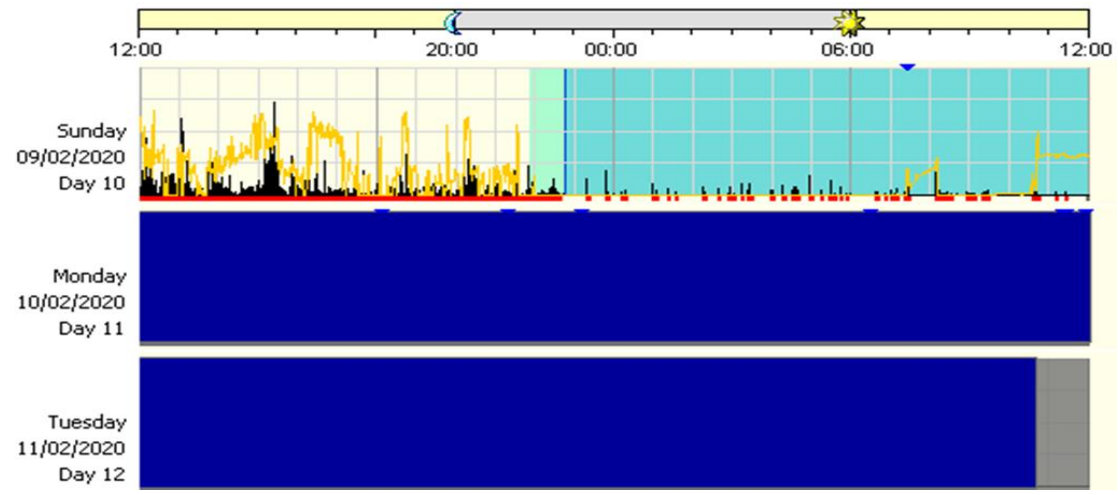
Step 6

Adjust automatically calculated sleep intervals that have extended into daytime (beyond the wake up time reported in the sleep diary information). Visually determine in the actogram where the automatically coded sleep interval starts approximately around the time indicated by the sleep diary but continues beyond the wake up time reported in the sleep diary. Please note, you can still follow this step if sleep diary information is missing following the epochs principle if necessary.

- WAKE UP TIME APPEARS 'TOO LATE': Identify the last 40 epochs coded as **0 in sleep/wake column** that occur before the wake up time indicated in the sleep diary information. Look ahead for 20 epochs coded as **1 in sleep/wake column** and identify the last epoch coded as 0 before the 20 epochs coded as 1. When adjusting the sleep interval here, keep the original start time of the automatically calculated sleep interval.

Automatically calculated sleep interval has extended into the daytime, as an actiwatch removal occurred soon after waking. Although a wake up time is not indicated in the mobile app sleep diary (as it does not exist for the final morning of the ten day assessment) and the event marker has not been pressed, the sleep interval end time can be adjusted. Previous wake up times reported in the mobile app vary between 06.00am and 08.45am. Using this information as a guide, the data list is inspected. Around 06.00am on the morning of Friday 6th, 40 epochs coded as 0 are identified in the data list (end of 40 epochs at 05:53:00). Looking ahead, 20 epochs coded as 1 are found. Last 0 before this sequence is recorded to indicate new end time of sleep interval = 06:49:30.

a. Please note, if the last epoch coded as 0 before the 20 epochs coded as 1 is *after* the original automatically coded sleep interval end time do not adjust the sleep interval.
b. If 20 epochs coded as 1 cannot be found to adjust the sleep interval end time (i.e an actiwatch removal occurs soon after waking), this sleep interval cannot be included. Exclude this 24 hour period from the actogram. First delete this sleep interval, then enter exclusion period from 12:00 – 12:00 (Interval → Add interval → Interval type: excluded).

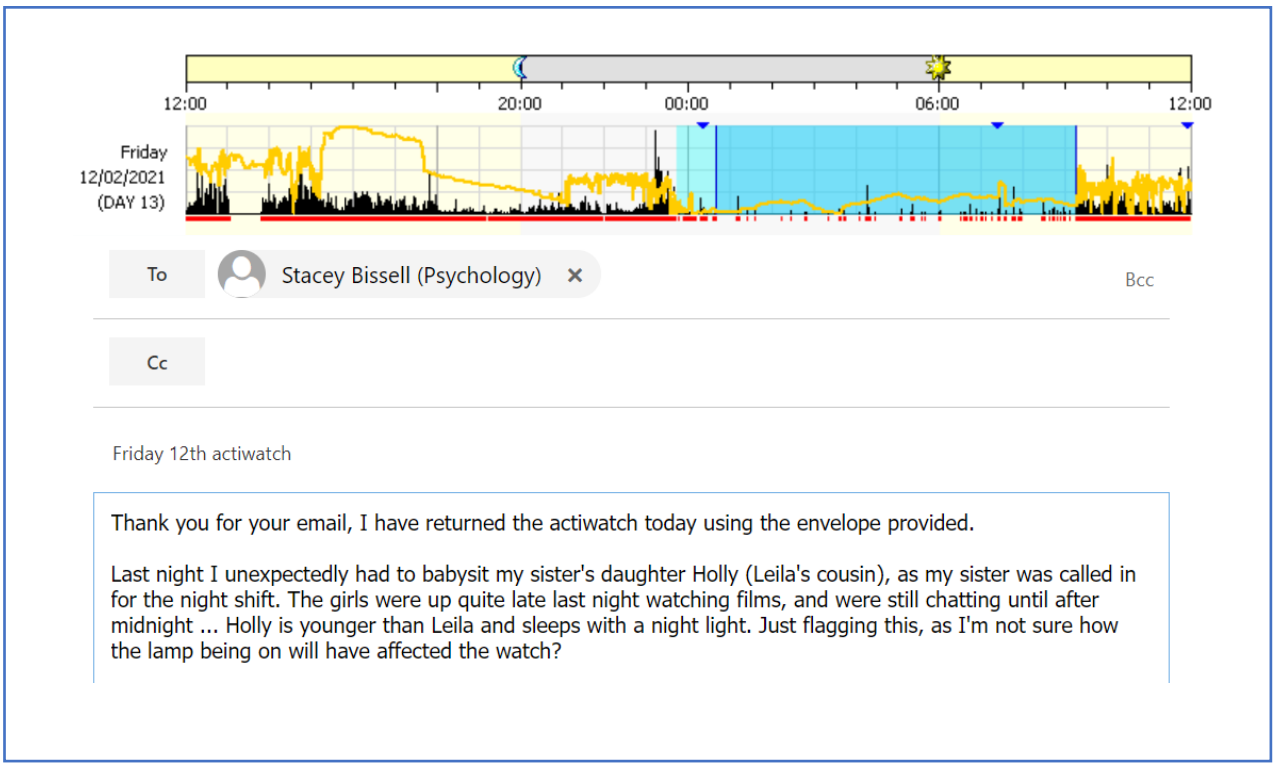


Need to adjust automatically calculated sleep interval for Sunday 9th. Event marker has been pressed at 07:27:00. Previous wake up times reported in the mobile app vary between 07.00am and 08.30am. Using this information as a guide, the data list is inspected. Around 07.00am on the morning of Monday 10th, 40 epochs coded as 0 are identified in the data list (end of 40 epochs at 06:37:00). Looking ahead, 20 epochs coded as 1 cannot be found. Last 0 before this sequence cannot be recorded to indicate a new end time. This sleep interval needs to be deleted, and an exclusion interval entered from 12:00 – 12:00 on Sunday 9th.

Step 7

Exclude nights where parents reported that the child had a sleepover with a friend/experienced sleep that is not defined as 'typical' as part of their usual routine (see mock example below). Exclude this 24 hour period from the actogram. First delete this sleep interval, then enter exclusion period from 12:00 – 12:00 (Interval → Add interval → Interval type: excluded).

a. Please note, provisions are made within the mobile app sleep diary for overnight respite/overnight care by family members or relatives, if this is part of the child's usual routine (i.e sleeping overnight at grandparents, co-parenting arrangement). If sleep diary has been completed by parent/relative/professional according to pre-determined arrangements on these respite/alternative childcare nights, these nights do not need to be excluded.



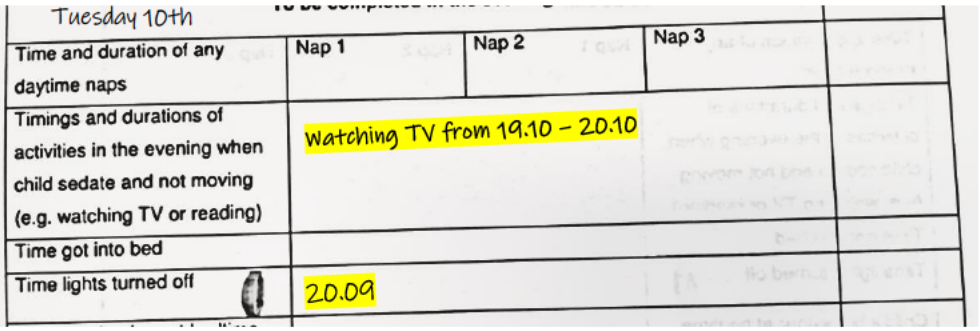
Step 8

Adjust sleep intervals where automatically calculated interval start time overlaps with sedentary activity or short actiwatch removal (e.g. watch removal that coincides with bath time before bed) reported in the sleep diary information.

a. For each night, check if any of these activities/short removals overlap with the automatically calculated sleep interval for that night.
b. If the sedentary activity/short removal in the sleep diary ends before the automatically calculated sleep interval created in Actiware, do not change the sleep interval for this given night.
c. If the automatically calculated sleep interval starts during the period of sedentary activity/actiwatch removal, **keep the automatically coded end time**, but change the start time of the sleep interval according to the following guidance;
   - If the diary 'time lights turned off' and the event marker are congruent (+/- 15 minutes) use the time the event marker was pressed as the start of the adjusted sleep interval.
   - If the diary 'time lights turned off' and event marker are incongruent (> +/- 15 minutes) use the time the event marker was pressed as the start of the adjusted sleep interval.

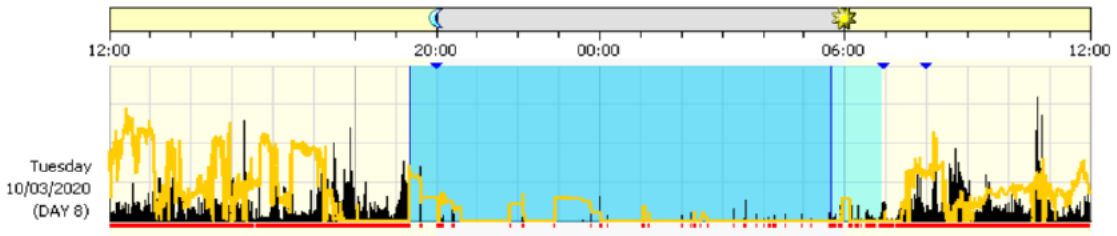
The following actions apply if the event marker or sleep diary information cannot be used:

i. If the event marker was pressed before/during the sedentary activity or removal, use the diary 'time lights turned off' as the start of the adjusted sleep interval.
ii. If the event marker was not pressed, use parent reported 'time lights turned off' as the start of the adjusted sleep interval.
iii. If the 'time lights turned off' is +/- 15 minutes congruent with the **start time** of the sedentary activity (i.e event marker is being used to indicate when the child goes to lie in bed and watch television, not being used to indicate lights out to begin sleep), 'time lights turned off' cannot be used reliably. Use the **end time of the sedentary activity/short removal** in the sleep diary as the start of the adjusted sleep interval.
iv. If the event marker was not pressed and the sleep diary does not report 'time lights turned off' **use the end time of the sedentary activity/short removal** in the sleep diary as the start of the adjusted sleep interval.



Tuesday 10th

Time and duration of any daytime naps	Nap 1	Nap 2	Nap 3	
Timings and durations of activities in the evening when child sedate and not moving (e.g. watching TV or reading)	Watching TV from 19.10 – 20.10			
Time got into bed				
Time lights turned off	20.09			



Overlap between automatically calculated sleep interval (19:22:30-06:53:00) and sedentary activity reported in sleep diary. Event marker pressed at 20:02:00 – pressed during sedentary activity and cannot be used. Lights out information reported in sleep diary as 20.09pm. Adjust sleep interval to 20:09:00-06:53:00.

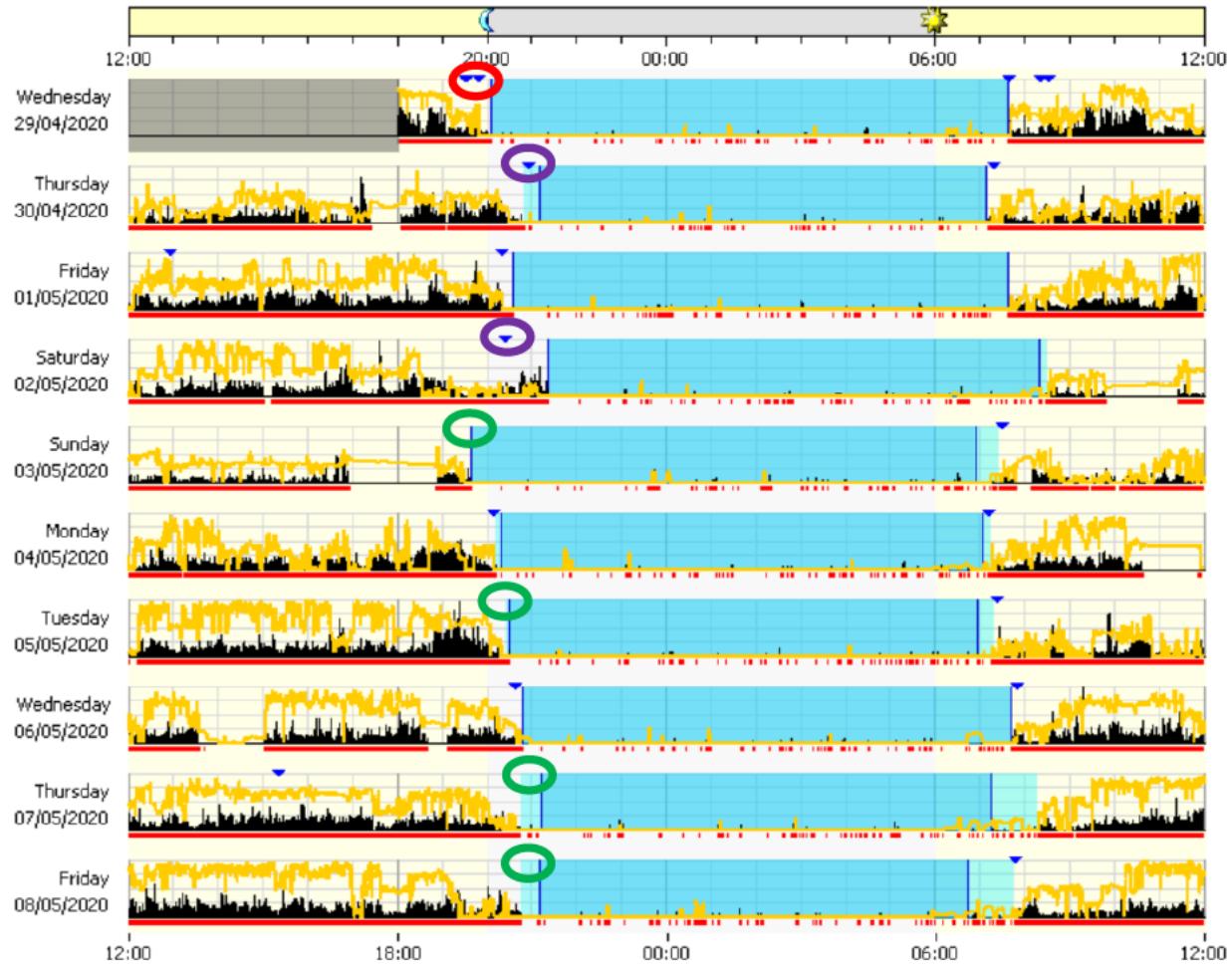
Step 9

Visually inspect the actogram and review the sleep diary information. Look over the whole data collection period and note the number of nights where:

a. The event marker is missing
b. The event marker has been pressed multiple times within two hours of the automatically calculated sleep interval start time
c. The sleep diary information indicates that the event marker was pressed at the incorrect time

THE EVENT MARKER SHOULD BE DEEMED INACCURATE

- If on half the nights or more (5/10, 4/7) any of these apply, the event marker is deemed inaccurate for the **whole sleep assessment**. Use the **alternative algorithm** to decide whether the start of the sleep interval needs to be changed FOR ALL NIGHTS OF THE SLEEP ASSESSMENT.
- If the event marker is deemed inaccurate for a minority of nights (1/10, 3/7), even if only on one night, use the **alternative algorithm** to decide whether the start of the sleep interval needs to be changed FOR EACH NIGHT SPECIFICALLY WHERE THE EVENT MARKER IS DEEMED INACCURATE.



On Wednesday 29th the event marker has been pressed multiple times within two hours of the automatically calculated sleep interval. On Thursday 30th and Saturday 2nd, the event marker has been identified as inaccurate within the mobile app diary. On Sunday 3rd, Tuesday 5th, Thursday 7th and Friday 8th the event marker is missing. This means that the event marker is inaccurate for the majority of nights (7/10), and so the event marker should be discounted FOR ALL NIGHTS OF THE SLEEP ASSESSMENT. The alternative algorithm should be used for every night in the sleep assessment (including Friday 1st, Monday 4th and Wednesday 6th).

(If the event marker has been discounted on half the nights or more, do not follow these guidelines, follow the alternative algorithm for all nights).

Use the following guidelines to decide whether to change the start of the sleep interval, for nights when the event marker **has not** been discounted.

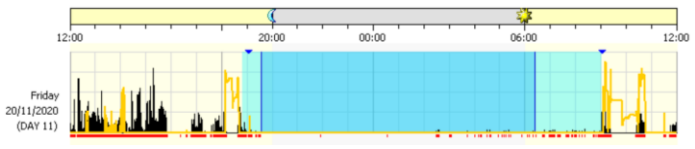
i. Look at the event marker, sleep diary and the automatically calculated sleep interval start time. If they are concordant (all three within +/-15 minutes of each other; SI – LO, SI – EM, EM – LO = +/-15 minutes) then leave the automatically calculated sleep interval.

ii. If the event marker and sleep diary are concordant but either are discordant with the automatically calculated sleep interval start time, adjust the start time of the sleep interval to the event marker time.

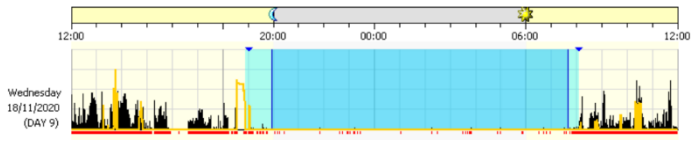
iii. If the event marker is discordant with the sleep diary but concordant with the automatically calculated sleep interval start time, leave the automatically calculated sleep interval.

iv. If the sleep diary is discordant with the event marker but concordant with the automatically calculated sleep interval start time, leave the automatically calculated sleep interval.

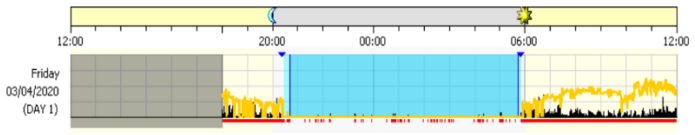
v. If the sleep diary, event marker and automatically calculated sleep interval are all discordant, leave the automatically calculated sleep interval.



Sleep interval = 18:50:30
Event marker = 19:06:00
Sleep diary = 19:20:00
Event marker and sleep diary are concordant, event marker discordant with sleep interval =
Adjust to event marker



Sleep interval = 18:55:00
Event marker = 19:03:30
Sleep diary = 19:02:00
Event marker and sleep diary and sleep interval are concordant =
Do not adjust sleep interval



Sleep interval = 20:28:00
Event marker = 20:24:30
Sleep diary = 20:45:00
Event marker and sleep diary are discordant, event marker concordant with sleep interval =
Do not adjust sleep interval

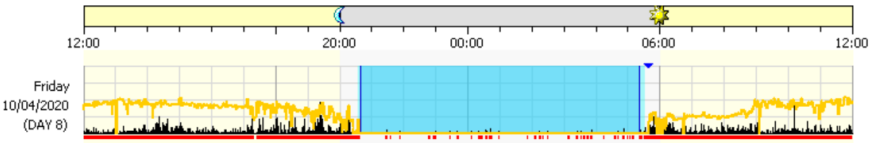
ALTERNATIVE ALGORITHM

- Use when the event marker is deemed inaccurate for the **whole sleep assessment**. Use the **alternative algorithm** to determine whether changing the sleep interval is required FOR ALL NIGHTS OF THE SLEEP ASSESSMENT.
- If the event marker is deemed inaccurate for a minority of nights (even if this is just 1/10, 3/7) use the **alternative algorithm** to determine whether changing the sleep interval is required FOR EACH NIGHT SPECIFICALLY WHERE THE EVENT MARKER IS DEEMED INACCURATE.

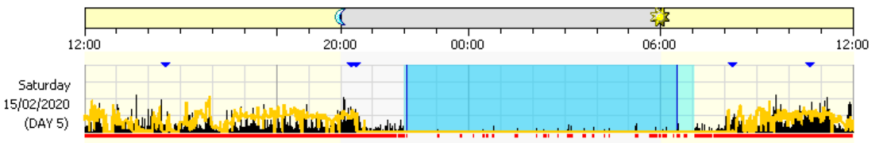
Use the following guidelines to decide whether to change the start of the sleep interval, for nights when the event marker **cannot be considered**.

i. If the event marker has been identified as inaccurate, but the sleep diary "time lights out" and sleep interval start time are +/- 15 minutes **concordant**, leave the automatically calculated sleep interval for that night.

ii. If the event marker has been identified as inaccurate, and the sleep diary "time lights out" and sleep interval start time are +/- 15 minutes discordant, use the child's sleep diary "time lights out" to change interval start time for that night.



EVENT MARKER IS MISSING
Sleep interval = 20:34:30
Sleep diary = 20:38:00
Sleep interval and sleep diary are concordant =
Do not adjust sleep interval



EVENT MARKER PRESSED MULTIPLE TIMES
Sleep interval = 22:00:00
Sleep diary = 20:30:00
Sleep interval and sleep diary are discordant =
Adjust to sleep diary

Appendix J.

Mothers Sleep Diary

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Sleep 1						
Time to bed	**Time to bed**	**Time to bed**	**Time to bed**	**Time to bed**	**Time to bed**	**Time to bed**
Time out of bed in morning	**Time out of bed in morning**	**Time out of bed in morning**	**Time out of bed in morning**	**Time out of bed in morning**	**Time out of bed in morning**	**Time out of bed in morning**
Sleep 2						
Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake
Sleep 3						
Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake
Sleep 4						
Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake
Sleep 5						
Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake
Sleep 6						
Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake	Time to sleep Time awake
Notes/ Daytime naps						

Appendix . K

Ethical Approval Email Following Amendment Request

Re: Application for amendment ERN_21-1164A

From: Susan [redacted] (Research Support Services)
Sent: 13 July 2022 13:58
To: Andrew Surtees (Psychology)
Cc: Catherine Gercs (ClinPsyD Clinical Psychol FT); Angharad Chidgey (ClinPsyD Clinical Psychol FT)
Subject: Application for amendment ERN_21-1164A

Dear Dr Surtees

Re: "Relationship between sleep deprivation, perinatal anxiety, maternal mind-mindedness and emotional recognition in new mothers"
Application for amendment ERN_21-1164A

Thank you for the above application for amendment, which was reviewed by the Science, Technology, Engineering and Mathematics Ethical Review Committee.

On behalf of the Committee, I can confirm that this amendment now has full ethical approval.

I would like to remind you that any substantive changes to the nature of the study as now amended, and/or any adverse events occurring during the study should be promptly brought to the Committee's attention by the Principal Investigator and may necessitate further ethical review. A revised amendment application form is now available at https://intranet.birmingham.ac.uk/finance/accounting/Research-Support-Group/Research-Ethics/Ethical-Review-Forms.aspx . Please ensure this form is submitted for any further amendments.

Please also ensure that the relevant requirements within the University's Code of Practice for Research and the information and guidance provided on the University's ethics webpages (available at https://intranet.birmingham.ac.uk/finance/accounting/Research-Support-Group/Research-Ethics/Links-and-Resources.aspx) are adhered to and referred to in any future applications for ethical review. It is now a requirement on the revised application form (https://intranet.birmingham.ac.uk/finance/accounting/Research-Support-Group/Research-Ethics/Ethical-Review-Forms.aspx) to confirm that this guidance has been consulted and is understood, and that it has been taken into account when completing your application for ethical review.

Please be aware that whilst Health and Safety (H&S) issues may be considered during the ethical review process, you are still required to follow the University's guidance on H&S and to ensure that H&S risk assessments have been carried out as appropriate. For further information about this, please contact your School H&S representative or the University's H&S Unit at healthandsafety@contacts.bham.ac.uk.

If you require a hard copy of this correspondence, please let me know.

Kind regards

Mrs [redacted]
Research Ethics Manager
Research Support Group
University of Birmingham
Email: [redacted]
Video/phone: If you would like to arrange a Teams/Zoom/telephone call, please email me and I will get in touch with you as soon as possible.
Web: https://intranet.birmingham.ac.uk/finance/RSS/Research-Support-Group/Research-Ethics/index.aspx
Postal address: Mrs [redacted] Finance Office, University of Birmingham, [redacted], Edgbaston, Birmingham, B15 2TT.

Please be aware that **the University is moving to a new research ethics review system, Ethics Review Manager (ERM), to replace the current online Self Assessment Forms (SAFs) and for Ethical Review (AER). In the initial phase from 13th June 2022, ERM will be piloted for all PGR and unfunded staff projects.** Funded staff projects will continue to use the Worktribe ethics checklist and AER form until the end of the year, when the second phase of ERM will be fully rolled out to these too. Further information about ERM will be available from midday on 13th June 2022 at https://intranet.birmingham.ac.uk/finance/rss/ethics-and-governance/research-ethics/index.aspx.

Appendix L

Tests of Normality

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Total Sleep Time_Average - T1	.177	14	.200*	.910	14	.155
Sleep Onset Latency_Average - T1	**.258**	**14**	**.012**	**.712**	**14**	**<.001**
Sleep Efficiency_Average - T1	.113	14	.200*	.961	14	.743
Wake After Sleep Onset_Average - T1	.165	14	.200*	.960	14	.729
Total Sleep Time_Average - T2	.169	14	.200*	.948	14	.528
Sleep Onset Latency Average - T2	.166	14	.200*	.938	14	.388
Sleep Efficiency_Average - T2	**.261**	**14**	**.011**	**.796**	**14**	**.004**
Wake After Sleep Onset_Average - T2	**.256**	**14**	**.013**	**.768**	**14**	**.002**
(Diary) Total Sleep Time_Average - T1	.225	14	.053	.899	14	.109
(Diary) Sleep Onset Latency_Average - T1	**.210**	**14**	**.097**	**.766**	**14**	**.002**
(Diary) Sleep Efficiency_Average - T1	.184	14	.200*	.948	14	.533
(Diary) Wake After Sleep Onset_Average - T1	.171	14	.200*	.890	14	.082
(Diary) Total Sleep Time_Average - T2	.215	14	.078	.883	14	.064
(Diary) Sleep Onset Latency_Average - T2	**.262**	**14**	**.010**	**.829**	**14**	**.012**
(Diary) Sleep Efficiency_Average - T2	.194	14	.161	.879	14	.057
(Diary) Wake After Sleep Onset_Average - T2	**.270**	**14**	**.007**	**.851**	**14**	**.023**
Appropriate Controlled for Verbosity	.141	14	.200*	.958	14	.697
Non-attuned Controlled for Verbosity	.193	14	.165	.878	14	.055

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Appendix M.

Correlations of sleep measures.

Correlations

[DataSet2] C:\Users\Student#\Downloads\THESIS DATA SET.sav

Nonparametric Correlations

Correlations

			Total Sleep Time_Average - T1	Sleep Efficiency_Average - T1	Wake After Sleep Onset_Average - T1	(Diary) Total Sleep Time_Average - T1	(Diary) Sleep Efficiency_Average - T1	(Diary) Wake After Sleep Onset_Average - T1
Spearman's rho	Total Sleep Time_Average - T1	Correlation Coefficient	1.000	.357	-.095	.686**	-.079	.364
		Sig. (2-tailed)	.	.068	.639	<.001	.707	.073
		N	27	27	27	25	25	25
	Sleep Efficiency_Average - T1	Correlation Coefficient	.357	1.000	-.681**	.199	.314	-.029
		Sig. (2-tailed)	.068	.	<.001	.340	.127	.892
		N	27	27	27	25	25	25
	Wake After Sleep Onset_Average - T1	Correlation Coefficient	-.095	-.681**	1.000	.058	-.182	.109
		Sig. (2-tailed)	.639	<.001	.	.781	.385	.604
		N	27	27	27	25	25	25
	(Diary) Total Sleep Time_Average - T1	Correlation Coefficient	.686**	.199	.058	1.000	.553**	-.089
		Sig. (2-tailed)	<.001	.340	.781	.	.002	.646
		N	25	25	25	29	29	29
	(Diary) Sleep Efficiency_Average - T1	Correlation Coefficient	-.079	.314	-.182	.553**	1.000	-.393*
		Sig. (2-tailed)	.707	.127	.385	.002	.	.035
		N	25	25	25	29	29	29
	(Diary) Wake After Sleep Onset_Average - T1	Correlation Coefficient	.364	-.029	.109	-.089	-.393*	1.000
		Sig. (2-tailed)	.073	.892	.604	.646	.035	.
		N	25	25	25	29	29	29

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Correlations

			Total Sleep Time_Average - T2	Sleep Efficiency_Average - T2	Wake After Sleep Onset_Average - T2	(Diary) Total Sleep Time_Average - T2	(Diary) Sleep Efficiency_Average - T2	(Diary) Wake After Sleep Onset_Average - T2
Spearman's rho	Total Sleep Time_Average - T2	Correlation Coefficient	1.000	.098	.009	.139	-.156	.063
		Sig. (2-tailed)	.	.689	.972	.581	.537	.804
		N	20	19	19	18	18	18
	Sleep Efficiency_Average - T2	Correlation Coefficient	.098	1.000	-.942**	.179	.406	-.665**
		Sig. (2-tailed)	.689	.	<.001	.478	.095	.003
		N	19	20	19	18	18	18
	Wake After Sleep Onset_Average - T2	Correlation Coefficient	.009	-.942**	1.000	-.096	-.363	.684**
		Sig. (2-tailed)	.972	<.001	.	.715	.152	.002
		N	19	19	19	17	17	17
	(Diary) Total Sleep Time_Average - T2	Correlation Coefficient	.139	.179	-.096	1.000	.597**	-.512**
		Sig. (2-tailed)	.581	.478	.715	.	.001	.008
		N	18	18	17	26	26	26
	(Diary) Sleep Efficiency_Average - T2	Correlation Coefficient	-.156	.406	-.363	.597**	1.000	-.727**
		Sig. (2-tailed)	.537	.095	.152	.001	.	<.001
		N	18	18	17	26	26	26
	(Diary) Wake After Sleep Onset_Average - T2	Correlation Coefficient	.063	-.665**	.684**	-.512**	-.727**	1.000
		Sig. (2-tailed)	.804	.003	.002	.008	<.001	.
		N	18	18	17	26	26	27

**. Correlation is significant at the 0.01 level (2-tailed).