Research Review: Do parent ratings of infant negative emotionality and self-regulation predict psychopathology in childhood and adolescence? A systematic review and meta-analysis of prospective longitudinal studies.

Katarzyna Kostyrka-Allchorne[1], Sam Wass[2] & Edmund J S Sonuga-Barke[1,3].

1. Department of Child & Adolescent Psychiatry, Institute of Psychiatry, Psychology & Neuroscience, King's College London, UK.
2. School of Psychology, University of East London, UK
3. Department of Child & Adolescent Psychiatry, Aarhus University, Denmark.

Correspondence to Dr Katarzyna Kostyrka-Allchorne, Department of Child and Adolescent Psychiatry, Institute of Psychiatry, Psychology & Neuroscience, King's College London, 16 DeCrespigny Park, London SE5 8AF, UK, email: kasia.kostyrka-allchorne@kcl.ac.uk

Running head: Infant temperament and later psychopathology: meta-analysis

Abstract

Background: Identifying low cost and easy to implement measures of infant markers of later psychopathology may improve targeting of early intervention for prevention. Because of their early manifestation, relative stability and overlap with constructs central to affect-based dimensions of child and adolescent psychopathology, negative emotionality and self-regulation have been the focus of this research. We conducted a meta-analysis of longitudinal studies examining the prospective association between infant temperament measured with parent ratings and child/adolescent psychopathology.

Methods: A systematic literature search for prospective longitudinal studies, which included measures of questionnaire-assessed infant temperament (negative emotionality, self-regulation, behavioural inhibition, surgency/extraversion, activity level) and symptoms of child or adolescent mental health (externalising, internalising) and neuro-developmental problems (attention-deficit/hyperactivity disorder [ADHD], autism spectrum disorder [ASD]), was conducted. Standardised estimates of association were calculated and pooled in meta-analyses.

Results: Twenty-five studies (n = 28,425) met inclusion criteria. Small associations were seen between psychopathology aggregated across all domains and infant negative emotionality (r = .15; p < .001) and self-regulation (r = -.19; p = .007). Effects were also significant but weaker for behavioural inhibition (r = .10; p = .027) and activity level (r = .08; p = .016). Surgency/extraversion was not significantly associated with psychopathology in general (r = -.04; p = .094); however, it was negatively associated with ASD (r = .-097, p = .015). Significant correlations were observed with some outcomes isomorphic with predictors; internalising problems and behavioural inhibition (r = .10; p=.013), ADHD symptoms and activity level (r = .19; p=.009).

Conclusion: Questionnaire-based assessments of infant negative emotionality may have transdiagnostic potential to contribute to a risk index of later childhood psychopathology. Behavioural inhibition, surgency/extraversion and activity ratings may provide more specific predictive power. More data from prospective studies are required before the potential of self-regulation and surgency/extraversion can be properly gauged.

Introduction

Recognition of the scale and associated burden of child and adolescent psychopathology (Polanczyk, Salum, Sugaya, Caye, & Rohde, 2015) has motivated a search for ways to screen for infant risk markers to improve the targeting of early intervention and prevention efforts (Sonuga-Barke & Halperin, 2010). Identifying such markers is a complex process given the dynamic and heterogeneous nature of developmental pathways from risk to disorder (Cicchetti, 1989). These pathways are not singular, linear or fixed, but are shaped by bi-directional associations between child characteristics and social context (Cicchetti & Toth, 2009). This means both that a single risk factor can create vulnerability for different psychopathological outcomes (multi-finality) and that different risk factors can contribute to the same outcome (equifinality; Cicchetti & Rogosch, 1996) .

Temperament manifests early in life and shows a degree of developmental stability and cross-setting consistency (Goldsmith et al., 1987; Shiner et al., 2012; Stifter & Dollar, 2016), therefore, it has obvious potential as an early marker of risk for later psychopathology (De Pauw & Mervielde, 2010; Frick, 2004; Nigg, 2006; Stifter & Dollar, 2016). While there is substantial variability in the way temperament has been conceptualised and measured in the four major approaches (i.e., Buss & Plomin, 1975; Goldsmith & Campos, 1982; Rothbart, 1981; Thomas & Chess, 1977), there is consensus that it reflects both the extent to which individuals respond to their environment (i.e., reactivity) and their ability to modulate and control these responses (i.e., regulation; Rothbart, 2004). Previous theoretical reviews that aimed to capture a set of common temperament dimensions within one taxonomy (e.g., De Pauw & Mervielde, 2010; Mervielde & Asendorpf, 2000; Rettew & McKee, 2005; Shiner et al., 2012; Zentner & Bates, 2008), converged on the four key constructs of attention/regulatory behaviours, emotionality (with emphasis on negative emotions; see Mervielde, De Clercq, De Fruyt, & Van Leeuwen, 2005), activity, and surgency/extraversion.

Of particular interest within child and adolescent psychopathology are the constructs of negative emotionality and emotion regulation (e.g., Carthy, Horesh, Apter, & Gross, 2010; Hankin et al., 2017; McLaughlin, Hatzenbuehler, Mennin, & Nolen-Hoeksema, 2011; Nigg, Goldsmith, & Sachek, 2004; Silk, Steinberg, & Morris, 2003; Wheeler Maedgen & Carlson, 2000). Emotions are responses elicited by salient events in ones' environment, which trigger changes on a behavioural, experiential and physiological level (Gross & Muñoz, 1995). Negative emotionality captures the threshold, amount and intensity of experiencing negative emotions and distress (Rettew & McKee, 2005). This construct encompasses, but is not limited to, the traits of fear, sadness and discomfort, which are included in the factor of negative affectivity proposed by Rothbart and colleagues (Putnam, Rothbart, & Gartstein, 2008; Rothbart, 1981; Rothbart, Ahadi, Hershey, & Fisher, 2001).

In this review, temperamental traits involved in regulation of emotions are captured in the construct of self-regulation. This construct includes regulating through orienting towards visual, auditory and tactile sources of comfort (Gartstein & Rothbart, 2003; Rothbart, Posner, & Kieras, 2006) present from early infancy and through attentional and inhibitory processes, which develop in toddlerhood (Rothbart et al., 2001). Although temperamental self-regulation is thought to play a crucial role in managing and expressing emotions (Eisenberg, Smith, Sadovsky, & Spinrad, 2004), it is also involved in modulation of cognition (see Nigg, 2017).

Excessive negative emotionality and poor emotion regulation have been implicated across multiple domains of children and adolescent mental health (both internalising and externalising; e.g., Carthy et al., 2010; McLaughlin et al., 2011; Silk et al., 2003) and neuro-developmental conditions (e.g., ADHD; Wheeler Maedgen & Carlson, 2000). Therefore, we conducted a systematic review and meta-analysis of longitudinal studies to test the hypothesis that variation in infant temperamental traits of negative emotionality and self-regulation (assessed before 24 months) would prospectively predict psychopathology before age 18.

To examine how specific the infant temperament-disorder link was to negative emotionality and self-regulation, we also examined three related temperament constructs, which have been theoretically and empirically linked to psychopathology: behavioural inhibition (Lahat, Hong, & Fox, 2011; Pérez-Edgar & Fox, 2005), surgency/extraversion (Olino, Dougherty, Bufferd, Carlson, & Klein, 2014; Schwartz et al., 2009) and activity level (Auerbach et al., 2005; Stringaris, Maughan, & Goodman, 2010). Behavioural inhibition is a distinct but related construct to negative emotionality, and arises in novel or risky situations (Zentner & Bates, 2008). In this review, behavioural inhibition encompasses shyness, fearfulness and withdrawal from novel or social situations. Activity level typically captures the amount of a child's physical movement (Eaton, 1994). Although in some models of temperament activity level is included in the construct of surgency/extraversion together with positive affect, pleasure-seeking, and impulsivity (i.e., Rothbart et al., 2001), in other models it is an independent dimension (e.g., Buss & Plomin, 1975; Thomas & Chess, 1977). Therefore, when primary data allowed, activity level was analysed as a separate construct. The detailed information about temperament constructs used in this review, including details of which specific temperament measures were included under which construct, is presented in Table 1.

If temperamental markers are to be of value as a basis for the targeting of early intervention to individuals at elevated risk of later psychopathology, they need to be low cost and easily implementable in large population screening exercises. For this reason, our review was limited to questionnaire-based measures of parents' ratings and studies using either laboratory tests or direct observation were excluded (see Figure 1).

Child and adolescent psychopathology outcomes included internalising and externalising problems (Achenbach & Edelbrock, 1984). The internalising dimension encompasses inward-directed or overcontrolled behaviour, such as mood disorders and anxiety (Krueger & Markon, 2006; Stifter & Dollar, 2016). The externalising dimension covers disinhibited and outward-

directed behaviour including aggression, rule-defiance, and conduct problems (Hinshaw, 1992; Krueger & Markon, 2006). Outcomes also included two highly prevalent neurodevelopmental disorders: ASD and ADHD because of their early onset (Ozonoff et al., 2010), high phenotypic heterogeneity (Ercan et al., 2016; Kim, Macari, Koller, & Chawarska, 2016) and substantial impact on the quality of life of the affected children and their families (Hakkaart-van Roijen et al., 2007; Wehmeier, Schacht, & Barkley, 2010).

We also tested two predictions regarding the timing of assessments. First, we expected associations to be stronger when temperament was measured in late infancy - based on evidence that temperamental stability increases after the age of 24 months (Lemery, Goldsmith, Klinnert, & Mrazek, 1999). Second, we predicted stronger associations with longer lags between infant and child and adolescent assessments - based on the notion that initial effects may be amplified over time as children with extreme temperament elicit negative reactions from family and peers which could worsen their behaviour over time (see the transactional model of development; Sameroff & Mackenzie, 2003).

[Table 1 here]

Method

Literature searches and inclusion criteria

Medline (PubMED), Cochrane, PsycARTICLES, ERIC, Web of Science, Google Scholar, ProQuest and EthOS were searched in November 2017 using combinations of the following key terms: infan*, child*, early, temperament, disposition, personality, regulation, emotio*, ADHD, ASD, externalising, internalising, depression, anxiety, conduct, mood, neurodevelopmen*. Additionally, hand searching was conducted to identify any studies that were not returned in the electronic databases. The last such search was conducted in June 2019. There was no restriction by manuscript publication date. Only articles written in English were considered for inclusion.

To be included in the review, the studies had to: (1) have a prospective longitudinal design, (2) include a validated questionnaire measure of one of the five selected temperament constructs (i.e., negative emotionality, self-regulation, behavioural inhibition, surgency/extraversion and activity level) before the age of 24 months, (3) measure one or more of five outcomes: symptoms of externalising disorders (e.g., oppositional defiant disorder, conduct disorder) or internalising disorders (e.g., anxiety, depression), ASD, ADHD or unspecified psychopathology before the age of 18 years. The outcomes could be represented as either a discrete category (e.g., a clinical diagnosis) or a continuous dimension (e.g., a score on a validated rating scale completed by a non-clinician, for example, a parent, teacher, self, etc.). When the same sample was used in multiple publications, the study with the longest interval between the earliest timepoint when temperament was measured and the latest timepoint when the outcome was measured was selected.

Selection process

Applying preselected inclusion criteria, electronic searches of the relevant databases returned 6,565 studies. Duplicates were removed (693) and the exclusion criteria applied to the title and the abstract, which excluded another 5,806 articles. Further hand searching of the reference lists in the relevant articles revealed additional 15 manuscripts. To assess the eligibility for inclusion, the full texts of the remaining 81 studies were screened by KKA to extract the following information: sample size, gender of participants (% males), informant, temperament construct, temperament measure, outcome type, outcome measure, lag between the temperament and outcome assessments, and age at the time of outcome assessment. Additionally, SW independently assessed 25% of these studies against inclusion criteria. Any doubts or disagreements between the two raters were resolved by ESB. Figure 1 presents the flowchart of the study selection process.

[Figure 1 here]

Analysis strategy

Meta-analyses were performed in the *R Metafor* package (Viechtbauer, 2010). Pearson's *r* correlation coefficient was selected as the standard estimate of effect size. When correlations were not reported in the article, they were either obtained by contacting the lead author or were calculated based on the other available information, such as the odds ratios, standardised mean difference (formulae available in Polanin & Snilstveit, 2016), or standardised beta coefficient (formulae available in Peterson & Brown, 2005).

As performing meta-analyses on raw correlation coefficients is not recommended (Borenstein, Hedges, Higgins, & Rothstein, 2011), analyses were conducted on the Fisher's r-to-z transformed scores ('ZCOR' function in R; Viechtbauer, 2010). To allow easier interpretation of the results, following the analyses, the Fisher's z scores were transformed back to correlation coefficients for reporting. The magnitude of the effect sizes was interpreted using cut-off points suggested by Cohen (1992): r =.10 indicated a small effect, r = .30 medium, and r = .50 a large effect. Finally, to test the significance of the differences between the magnitudes of the correlations, r.test function in the R *Psych* package was used (Revelle, 2019). Bonferroni correction was applied to the critical level of alpha.

A three-step analytical approach was adopted. In the first step, multiple effect sizes representing measures of the same temperament construct (e.g., shyness and fearfulness representing behavioural inhibition) were averaged to obtain a single value. The exact classifications used are given in Table 1. The same approach was adopted to reduce the number of effect sizes in studies investigating multiple outcomes within the same domain in the same sample (e.g., anxious/depressed symptoms and affective problems, both reflecting internalising outcomes; Table 1). In the second step, we considered studies in which temperament was measured at multiple time-points in infancy and the outcome was measured at multiple timepoints during childhood or adolescence. For both the predictors and the

outcomes, we included effect sizes obtained at the latest timepoint. Finally, we used multi-level models to address the dependency of effect sizes where the same paper contributed data on more than one predictor or outcome. In the models, level 1 (participants) contained the distribution of the sampling variance of all effect sizes extracted from primary studies. Level 2 of the model (outcomes) contained the distribution of the variance between effect sizes within each primary study and, finally, level 3 (studies) specified variance between studies included in the meta-analyses (Assink & Wibbelink, 2016). If effect sizes included in the subgroup analysis were extracted from independent samples, a two- rather a three-level random-effects model was used.

Separate models were computed for each of the five infant temperament constructs: negative emotionality, self-regulation, behavioural inhibition, activity level and surgency/extraversion. First, these models tested the association with psychopathology across the five outcome domains generally. We then conducted subgroup analysis focusing on specific psychopathology domains (i.e., ASD, internalising, externalising and ADHD). These subgroup analyses were performed only if there were three studies or more with relevant data. In additional analyses we examined, within each model, the effects of two categorical moderators: (1) age of temperament assessment, which was defined as early (0-12 months = 1) and late infancy (13-24 months = 0); (2) the type of informant (parent = 1, other or self = 0). We also included lag (i.e., the time between the temperament and outcome assessment) as a continuous moderator, which was mean centred for analyses.

Random effect models, which estimate average rather than common effects across studies, giving smaller studies relatively more weight, were deployed to counter the likely high degree of between-study heterogeneity expected given the many differences in study design features and wide range of sample sizes (Borenstein, Hedges, Higgins, & Rothstein, 2010; Riley, Higgins, & Deeks, 2011). Such models reduce the risk of Type I error (Hunter &

Schmidt, 2000; Viechtbauer & Cheung, 2010). Heterogeneity was assessed using Q-statistic and I^2 statistics. To test the effect of heterogeneity on the effect estimates we ran sensitivity analyses after removing extreme values identified using Cook's distance method (Viechtbauer & Cheung, 2010). We based these on the rule of thumb that a Cook's Di larger than three times the mean warrants inspection. We also visually assessed the plots to identify potentially influential studies. Rosenthal's Fail-Safe N (FSN) test was used to assess the extent of publication bias, that is, a preference towards publishing only significant findings in the included sample. Contour-enhanced funnel plots were also produced for each model to allow visual assessment of potential biases (Peters, Sutton, Jones, Abrams, & Rushton, 2008).

Results

Sample

Twenty-three articles published between 2000-2018 and two unpublished manuscripts were retained for analyses (28,425 participants aged 2 to 17 years). For study characteristics see Table 2. Thirteen studies reported on multiple temperament constructs and nine reported on multiple outcomes obtained from the same participants; three included outcome measures provided by more than one informant.

[Table 2 here]

Primary analysis

[Table 3 here]

Table 3 shows the effect sizes for the associations between five temperament constructs and childhood psychopathology outcomes. Negative emotionality (Figure 2), activity level and behavioural inhibition (Figure 3) were significantly positively associated with subsequent psychopathology. The effect sizes were small: r = .152, r = .075, and r = .097, respectively.

There was also a significant negative association between self-regulation (Figure 2) and psychopathology in general. This effect was small to medium in magnitude, r = -.19. The association with extraversion/surgency was negative (r = -.042) but not significant.

[Figure 2 here]

[Figure 3 here]

Q-statistic values presented in Table 3 show that heterogeneity was significant for all temperament constructs, except for extraversion/surgency. Removing extreme effect estimates substantially reduced heterogeneity for negative emotionality (Q = 56.6 to Q = 36.9), self-regulation (Q = 46.1 to Q = 12.6) and activity level (Q = 51.1 to Q = 13.4), but not for behavioural inhibition (Q = 56.4 to Q = 47.3). For detailed results, see Supplemental Materials (Table S1). Excluding extreme correlations did not result in substantial changes to the overall effect sizes. Moderator analyses found that the associations between activity level and childhood psychopathology were stronger when outcome ratings were provided by a parent, (β = .225) and when temperament measure was obtained in later infancy (β = -.175). There were no other significant moderators for any of the temperament constructs (all ps >.05, see Table S2 in Supplemental Materials).

Table S3 in Supplemental Materials presents the results of the tests of the differences between the magnitudes of the correlations (adjusted critical α = .007). Associations with childhood psychopathology were significantly stronger for negative emotionality and self-regulation than for the other temperament constructs that were examined in this meta-analysis. However, correlations with childhood psychopathology were as strong for negative emotionality as they were for self-regulation.

Subgroup analyses

Subgroup analyses (for details see Figures 2, 3) found that negative emotionality was significantly positively associated with ASD (r = .315, medium effect), internalising, externalising problems and ADHD (r = .142, r = .122 and r = .141, respectively; all small effects). Self-regulation was negatively associated with internalising problems (r = -.155, small effect) and ADHD (r = -.245, small-to-medium effect) but not ASD (r = -.220). There were too few studies to conduct subgroup analyses of the associations between self-regulation and externalising problems. There were also small positive associations between activity level and externalising problems (r = .079) and ADHD (r = .183) but not with internalising problems (r = .054). There were not enough studies to test the link between activity level and ASD. Extraversion/surgency was negatively associated with ASD (r = -.097, small effect) but not with internalising (r = .006) or externalising problems (r = -.032). There were too few studies with ADHD as outcome to conduct subgroup analysis. Finally, behavioural inhibition was positively associated with internalising problems (r = .092, small effect), but there were too few studies to test the associations with other types of outcomes.

Publication bias

Contour-enhanced funnel plots for the five temperament construct models are presented in Figure S1 (available in Supplemental Materials). There was little evidence of publication bias. The Rosenthal's FSN test suggested that, for negative emotionality, N=1757 studies would be required to change the result of the meta-analysis. For self-regulation the FSN indicated that N=206 would be required; for activity level, N=198; for surgency/extraversion, N=8; for behavioural inhibition, N=182. In sum, except for the construct of

surgency/extraversion, these results are robust and unlikely to change with the inclusion of further studies.

Discussion

Infant temperamental traits have been identified as putative early risk markers of later psychopathology. Questionnaire-based measures of parent ratings in principle offer a low-cost and easily implementable approach to screening that could help target interventions to children at risk of later psychopathology. We hypothesized that two constructs would be especially important in this regard: negative emotionality and self-regulation. We tested this by meta-analysing estimates of the association between these two constructs measured by parental questionnaires and psychopathology across multiple mental health and neuro-developmental domains obtained from prospective longitudinal studies. We then contrasted the strength of these associations with activity level, surgency/extraversion and behavioural inhibition to explore the specificity of effects. Both infant high negative emotionality and low self-regulation predicted increased rates of psychopathology, with slightly larger effect sizes than for the other constructs.

Over and above this primary finding there were three findings of note: First, except for surgency/extraversion, all infant temperament constructs were statistically significantly associated with later psychopathology when the different domains of psychopathology were collapsed. However, the effects sizes were small, with individual temperamental traits accounting for only between 7 and 19% of the variance in later psychopathology. The modest nature of these associations did not vary as a function of the age of assessment in infancy (except for activity level) or the length of the follow-up period.

The low magnitude of effect sizes was to some extent both surprising and disappointing. Surprising in as much as the overlap between temperament and personality trait dimensions and child and adolescent psychopathology is well established in previous studies (for reviews

see Clark, 2005; De Pauw & Mervielde, 2010; Muris & Ollendick, 2005; Nigg, 2006). Surprising also in that temperament traits appear to show a moderate degree of stability between infancy and childhood in prior longitudinal research (Pedlow, Sanson, Prior, & Oberklaid, 1993; Rothbart, Derryberry, & Hershey, 2000). The lack of strength of continuity was particularly striking where psychopathology outcomes were isomorphic with temperamental predictors. For example, one might have expected larger effects of the associations between self-regulation and externalising problems or behavioural inhibition and internalising problems.

The predictive power of questionnaire-measured infant temperament traits is weak - they can play only a limited role as indices of early risk for later psychopathology that might be useful for targeting infants at risk for later disorder. While disappointing this is consistent with the more general limited success of attempts to identify other sorts of early markers of later psychopathology. For example, research that examined longitudinal links between infant brain development and childhood psychopathology found only small correlations with internalising symptoms (e.g., Herba et al., 2010; Rogers et al., 2017) and ASD (e.g., Hazlett et al., 2017; Herba et al., 2010; Shen et al., 2017), while the evidence relating to ADHD is sparse and inconsistent (Bora, Pritchard, Chen, Inder, & Woodward, 2014; Ghassabian et al., 2013). In a similar way, the evidence linking infant attention and child neurodevelopmental disorders is mixed (for a review see Johnson, Gliga, Jones, & Charman, 2015).

The second finding of note is that negative emotionality and self-regulation may best serve as transdiagnostic risk markers for later psychopathology. However, both measures showed a lack of specificity. Elevated levels of negative emotionality were significantly associated with all measured outcomes (internalising, externalising, ASD and ADHD), and reduced levels of self-regulation were associated with internalising, ASD and ADHD.

This lack of specificity may relate to the fact that, for both negative emotionality and self-regulation, arousal systems are thought to play an important role in both affective and cognitive function (Geva & Feldman, 2008; Wass et al.). Early atypical development within arousal/regulatory systems may, therefore, lead to increased risk of multiple psychopathologies later in development (Conway, Raposa, Hammen, & Brennan, 2018). Other research has, similarly, discussed developmental mechanisms through which atypical effortful control during early development can lead to transdiagnostic increased risk of later psychopathology (Johnson, 2012).

However, for negative emotionality, the apparent lack of specificity may also be due to the heterogeneity of individual traits included in this construct (such as fear, frustration, anger, etc.; see Table 1) and their distinct links to the different domains of psychopathology (e.g., fear - internalising, anger - externalising; Stifter & Dollar, 2016). That is, combining the different individual traits into one overarching construct might have reduced our ability to capture the unique temperament-disorder pathways.

Similar considerations may also apply to our self-regulation construct. Because the top-down effortful processes required for self-regulation are not sufficiently developed in infancy (Kochanska, Murray, & Harlan, 2000), it is difficult to measure them reliably. Nevertheless, given the central role that self-regulation plays in models of child and adolescent psychopathology the relative dearth of studies looking at this construct in infancy is surprising, especially given the abundance of research examining the links between self-regulation and psychopathology in children of preschool age and older (e.g., Eisenberg et al., 2009; Espy, Sheffield, Wiebe, Clark, & Moehr, 2011; Lemery-Chalfant, Doelger, & Goldsmith, 2008; Martel & Nigg, 2006).

Finally, in contrast to generality of negative emotionality and self-regulation, infant activity level specifically predicted ADHD symptoms and externalising problems, while

behavioural inhibition predicted internalising problems. A novel finding was that low surgency/extraversion was predictive of ASD. However, it is important to note here that three of four included studies involved high-risk populations (i.e., siblings of individuals with ASD). Interestingly, for internalising disorders and ADHD, their associated temperament traits (i.e., behavioural inhibition and activity level) may be seen as the behavioural prodromes of the respective disorder - initial 'mild' symptoms that do not meet full diagnostic criteria (Einziger et al., 2018; Pérez-Edgar & Guyer, 2014). Whether behavioural inhibition and activity level confer early risk factors that contribute to the subsequent disorders or are indeed early appearing markers of the disorder itself is an important question, which is yet to be resolved.

Findings from this meta-analysis should be considered in light of several limitations. First, there is a lack of a clear distinction between which behaviours constitute temperament and which psychopathology (Lahey, 2004). In consequence, many items that are meant to capture temperament measure dimensions of psychopathology and vice versa (Nigg, 2006). The item overlap may lead to inflated estimates of the strength of the temperament-disorder associations (Sanson, Prior, & Kyrios, 1990), especially if data are solely based on information provided by a parent (Stifter & Dollar, 2016), which was the case for over 50% of the studies included in this review.

Second, different studies used different approaches to define the temperament constructs. Despite similarities in the names of some traits, most have been conceptualised in a variety of ways (Else-Quest, Hyde, Goldsmith, & Van Hulle, 2006). For example, in the Early Child Behavior Questionnaire, fear is operationalised as general "negative affect related to anticipated pain, distress and/or threat." (Putnam et al., 2008, p.389). In contrast, the Toddler Behavior Assessment Questionnaire (Goldsmith, 1996) measures fear in a more specific context (i.e., social and object fear). Therefore, combining the data derived from different

measures into one broad construct may have reduced the precision of the estimates obtained in this meta-analysis.

Third, this meta-analysis is limited to investigating simple linear models, in which a temperament construct is a single predictor of subsequent symptoms. However, the modest associations reported in this article suggests that there are likely to be other intrinsic and extrinsic factors that modulate the links between temperament and later psychopathology. Except for research on parenting (for review see Slagt, Dubas, Deković, & van Aken, 2016), very little is known about how other factors may shape the developmental trajectories from early temperament to later disorder. Thus, investigation of other moderators is a clear avenue for future research.

Fourth, for some construct, there were insufficient studies that met inclusion criteria to provide robust estimates of associations between infant traits and child and adolescent outcomes.

In summary, we found small but significant associations between infant temperament and later psychopathology suggesting that such measures can play a limited role in infant risk indices to help target children at risk. Four of five temperament constructs were associated with psychopathology in general. High negative emotionality and self-regulation have potential as a transdiagnostic risk markers for psychopathology. Conversely, behavioural inhibition, activity level and low surgency/extraversion may create a specific liability for internalising problems, ADHD and ASD symptoms, respectively. More data are needed on self-regulation and surgency/extraversion.

Key points:

- Identifying infant markers of later psychopathology is crucial for targeted early interventions aimed at reducing the likelihood of disorder and impairment.
- Questionnaire-based ratings of temperament are a low-cost and practical screening tool that could be easily implemented in clinical settings.
- This is the first meta-analysis of studies examining the prospective association between infant temperament and child and adolescent internalising, externalising and neurodevelopmental problems.
- High negative emotionality and self-regulation in infancy may be the transdiagnostic markers conferring increased vulnerability to psychopathology in general, while behavioural inhibition and activity level may allow making more specific predictions about later disorder.
- Overall, the predictive power of questionnaire measures of infant temperament is weak, thus limiting their potential role as useful screening tools for later psychopathology.

References

Abulizi, X., Pryor, L., Michel, G., Melchior, M., Van Der Waerden, J., & Group, E. M. C. C. S. (2017). Temperament in infancy and behavioral and emotional problems at age 5.5: The EDEN mother-child cohort. *PloS one, 12*(2), e0171971.

Achenbach, T. M., & Edelbrock, C. S. (1984). Psychopathology of childhood. *Annual Review of Psychology, 35*(1), 227-256.

Assink, M., & Wibbelink, C. J. (2016). Fitting three-level meta-analytic models in R: A step-by-step tutorial. *The Quantitative Methods for Psychology, 12*, 154-174.

Auerbach, J. G., Landau, R., Berger, A., Arbelle, S., Faroy, M., & Karplus, M. (2005). Neonatal behavior of infants at familial risk for ADHD. *Infant Behavior and Development, 28*(2), 220-224.

Beijers, R., Riksen-Walraven, M., Putnam, S., Jong, M. d., & Weerth, C. d. (2013). Early non-parental care and toddler behaviour problems: Links with temperamental negative affectivity and inhibitory control. *Early Childhood Research Quarterly, 28*(4), 714-722. doi:http://dx.doi.org/10.1016/j.ecresq.2013.06.002

Bora, S., Pritchard, V. E., Chen, Z., Inder, T. E., & Woodward, L. J. (2014). Neonatal cerebral morphometry and later risk of persistent inattention/hyperactivity in children born very preterm. *Journal of Child Psychology and Psychiatry, 55*(7), 828-838.

Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2010). A basic introduction to fixed-effect and random-effects models for meta-analysis. *Research synthesis methods, 1*(2), 97-111.

Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2011). *Introduction to meta-analysis*: John Wiley & Sons.

Bridgett, D. J. (2008). *Temperament development and early temperament predictors of psychopathology: Examination of developmental trajectories of increased temperament risk for psychopathology and the direct and indirect effects of infant temperament on toddler psychopathology outcomes.* (3370248 Ph.D.), Washington State University, Ann Arbor. Retrieved from https://search.proquest.com/docview/304441107?accountid=11862 http://openurl.ac.uk/ukfed:kcl.ac.uk?url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:dissertation&genre=dissertations+%26+theses&sid=ProQ:ProQuest+Dissertations+%26+Theses+A%26I&atitle=&title=Temperament+development+and+early+temperament+predictors+of+psychopathology%3A+Examination+of+developmental+trajectories+of+increased+temperament+risk+for+psychopathology+and+the+direct+and+indirect+effects+of+infant+temperament+on+toddler+psychopathology+outcomes&issn=&date=2008-01-01&volume=&issue=&spage=&au=Bridgett%2C+David+James&isbn=9781109307139&jtitle=&btitle=&rft_id=info:eric/&rft_id=info:doi/ ProQuest Dissertations & Theses A&I database.

Buss, A. H., & Plomin, R. (1975). *A temperament theory of personality development*: Wiley-Interscience.

Carthy, T., Horesh, N., Apter, A., & Gross, J. J. (2010). Patterns of Emotional Reactivity and Regulation in Children with Anxiety Disorders. *Journal of Psychopathology and Behavioral Assessment, 32*(1), 23-36. doi:10.1007/s10862-009-9167-8

Cicchetti, D. (1989). Developmental psychopathology: Some thoughts on its evolution. *Development and psychopathology, 1*(1), 1-4.

Cicchetti, D., & Rogosch, F. A. (1996). Equifinality and multifinality in developmental psychopathology. *Development and psychopathology, 8*(4), 597-600.

Cicchetti, D., & Toth, S. L. (2009). The past achievements and future promises of developmental psychopathology: The coming of age of a discipline. *Journal of Child Psychology and Psychiatry, 50*(1-2), 16-25.

Clark, L. A. (2005). Temperament as a unifying basis for personality and psychopathology. *Journal of abnormal psychology, 114*(4), 505.

Cohen, J. (1992). A power primer. *Psychological bulletin, 112*(1), 155.

Colder, C. R., Mott, J. A., & Berman, A. S. (2002). The interactive effects of infant activity level and fear on growth trajectories of early childhood behavior problems. *Development and psychopathology, 14*(1), 1-23.

Conway, C. C., Raposa, E. B., Hammen, C., & Brennan, P. A. (2018). Transdiagnostic pathways from early social stress to psychopathology: a 20-year prospective study. *Journal of Child Psychology and Psychiatry, 59*(8), 855-862.

De Pauw, S. S., & Mervielde, I. (2010). Temperament, personality and developmental psychopathology: A review based on the conceptual dimensions underlying childhood traits. *Child Psychiatry & Human Development, 41*(3), 313-329.

Eaton, W. O. (1994). Temperament, development, and the five-factor model: Lessons from activity level. *The developing structure of temperament and personality from infancy to adulthood*, 173-187.

Edwards, R. C., & Hans, S. L. (2015). Infant risk factors associated with internalizing, externalizing, and co-occurring behavior problems in young children. *Developmental psychology, 51*(4), 489.

Einziger, T., Levi, L., Zilberman-Hayun, Y., Auerbach, J. G., Atzaba-Poria, N., Arbelle, S., & Berger, A. (2018). Predicting ADHD symptoms in adolescence from early childhood temperament traits. *Journal of abnormal child psychology, 46*(2), 265-276.

GenericEisenberg, N., Smith, C., Sadovsky, A., & Spinrad, T. (2004). Effortful control: Relations with emotion regulation, adjustment, and socialization in childhood. u: Baumeister RF. In: Vohs KD [ur.] Handbook of self-regulation: Research, theory and applications ….

Eisenberg, N., Valiente, C., Spinrad, T. L., Cumberland, A., Liew, J., Reiser, M., . . . Losoya, S. H. (2009). Longitudinal relations of children's effortful control, impulsivity, and negative emotionality to their externalizing, internalizing, and co-occurring behavior problems. *Developmental psychology, 45*(4), 988.

Else-Quest, N. M., Hyde, J. S., Goldsmith, H. H., & Van Hulle, C. A. (2006). Gender differences in temperament: a meta-analysis. *Psychological bulletin, 132*(1), 33.

Ercan, E. S., Suren, S., Bacanlı, A., Yazici, K. U., Callı, C., Ozyurt, O., . . . Rohde, L. A. (2016). Decreasing ADHD phenotypic heterogeneity: searching for neurobiological underpinnings of the restrictive inattentive phenotype. *European child & adolescent psychiatry, 25*(3), 273-282.

Espy, K. A., Sheffield, T. D., Wiebe, S. A., Clark, C. A., & Moehr, M. J. (2011). Executive control and dimensions of problem behaviors in preschool children. *Journal of Child Psychology and Psychiatry, 52*(1), 33-46.

Feng, X., Shaw, D., & Silk, J. (2008). Developmental Trajectories of Anxiety Symptoms Among Boys Across Early and Middle Childhood. *J Abnorm Psychol, 117*(1), 32-47. doi:10.1037/0021-843X.117.1.32

Frick, P. J. (2004). Integrating research on temperament and childhood psychopathology: Its pitfalls and promise. *Journal of clinical child and adolescent psychology, 33*(1), 2-7.

Gartstein, M. A., & Bateman, A. E. (2008). Early manifestations of childhood depression: Influences of infant temperament and parental depressive symptoms. *Infant and Child Development, 17*(3), 223-248. doi:10.1002/icd.549

Gartstein, M. A., Putnam, S. P., & Rothbart, M. K. (2012). Etiology of preschool behavior problems: Contributions of temperament attributes in early childhood. *Infant Mental Health Journal, 33*(2), 197-211.

Gartstein, M. A., & Rothbart, M. K. (2003). Studying infant temperament via the revised infant behavior questionnaire. *Infant Behavior and Development, 26*(1), 64-86.

Geva, R., & Feldman, R. (2008). A neurobiological model for the effects of early brainstem functioning on the development of behavior and emotion regulation in infants: Implications for prenatal and perinatal risk. *Journal of Child Psychology and Psychiatry, 49*(10), 1031-1041.

Ghassabian, A., Herba, C. M., Roza, S. J., Govaert, P., Schenk, J. J., Jaddoe, V. W., . . . Tiemeier, H. (2013). Infant brain structures, executive function, and attention deficit/hyperactivity problems at preschool age. A prospective study. *Journal of Child Psychology and Psychiatry, 54*(1), 96-104.

Goldsmith, H. (1996). Studying temperament via construction of the Toddler Behavior Assessment Questionnaire. *Child development, 67*(1), 218-235.

Goldsmith, H. H., Buss, A. H., Plomin, R., Rothbart, M. K., Thomas, A., Chess, S., . . . McCall, R. B. (1987). Roundtable: What is temperament? Four approaches. *Child development*, 505-529.

Goldsmith, H. H., & Campos, J. J. (1982). Toward a theory of infant temperament. In *The development of attachment and affiliative systems* (pp. 161-193): Springer.

Gross, J. J., & Muñoz, R. F. (1995). Emotion regulation and mental health. *Clinical psychology: Science and practice, 2*(2), 151-164.

Hakkaart-van Roijen, L., Zwirs, B. W. C., Bouwmans, C., Tan, S., Schulpen, T., Vlasveld, L., & Buitelaar, J. (2007). Societal costs and quality of life of children suffering from attention deficient hyperactivity disorder (ADHD). *European child & adolescent psychiatry, 16*(5), 316-326.

Hankin, B. L., Davis, E. P., Snyder, H., Young, J. F., Glynn, L. M., & Sandman, C. A. (2017). Temperament factors and dimensional, latent bifactor models of child psychopathology: Transdiagnostic and specific associations in two youth samples. *Psychiatry research, 252*, 139-146.

Hazlett, H. C., Gu, H., Munsell, B. C., Kim, S. H., Styner, M., Wolff, J. J., . . . Botteron, K. N. (2017). Early brain development in infants at high risk for autism spectrum disorder. *Nature, 542*(7641), 348.

Herba, C. M., Roza, S. J., Govaert, P., van Rossum, J., Hofman, A., Jaddoe, V., . . . Tiemeier, H. (2010). Infant brain development and vulnerability to later internalizing difficulties: the Generation R study. *Journal of the American Academy of Child & Adolescent Psychiatry, 49*(10), 1053-1063.

Hinshaw, S. P. (1992). Externalizing behavior problems and academic underachievement in childhood and adolescence: causal relationships and underlying mechanisms. *Psychological Bulletin, 111*(1), 127.

Hunter, J. E., & Schmidt, F. L. (2000). Fixed effects vs. random effects meta-analysis models: Implications for cumulative research knowledge. *International Journal of Selection and Assessment, 8*(4), 275-292.

Johnson, M. H. (2012). Executive function and developmental disorders: the flip side of the coin. *Trends in Cognitive Sciences, 16*(9), 454-457.

Johnson, M. H., Gliga, T., Jones, E., & Charman, T. (2015). Annual Research Review: Infant development, autism, and ADHD–early pathways to emerging disorders. *Journal of Child Psychology and Psychiatry, 56*(3), 228-247.

Karevold, E., Roysamb, E., Ystrom, E., & Mathiesen, K. (2009). Predictors and Pathways From Infancy to Symptoms of Anxiety and Depression in Early Adolescence. *Dev Psychol, 45*(4), 1051-1060. doi:10.1037/a0016123

Kim, S. H., Macari, S., Koller, J., & Chawarska, K. (2016). Examining the phenotypic heterogeneity of early autism spectrum disorder: subtypes and short-term outcomes. *Journal of Child Psychology and Psychiatry, 57*(1), 93-102.

Kochanska, G., Murray, K. T., & Harlan, E. T. (2000). Effortful control in early childhood: continuity and change, antecedents, and implications for social development. *Developmental psychology, 36*(2), 220.

Krueger, R. F., & Markon, K. E. (2006). Understanding psychopathology: Melding behavior genetics, personality, and quantitative psychology to develop an empirically based model. *Current Directions in Psychological Science, 15*(3), 113-117.

Lahat, A., Hong, M., & Fox, N. A. (2011). Behavioural inhibition: Is it a risk factor for anxiety? *International Review of Psychiatry, 23*(3), 248-257.

Lahey, B. B. (2004). Commentary: Role of temperament in developmental models of psychopathology. *Journal of Clinical Child and Adolescent Psychology, 33*(1), 88-93.

Lahey, B. B., Van Hulle, C. A., Keenan, K., Rathouz, P. J., D'Onofrio, B. M., Rodgers, J. L., & Waldman, I. D. (2008). Temperament and Parenting during the First Year of Life Predict Future Child Conduct Problems. *Journal of abnormal child psychology, 36*(8), 1139-1158. doi:10.1007/s10802-008-9247-3

Lemery-Chalfant, K., Doelger, L., & Goldsmith, H. H. (2008). Genetic relations between effortful and attentional control and symptoms of psychopathology in middle childhood. *Infant and Child Development: An International Journal of Research and Practice, 17*(4), 365-385.

Lemery, K. S., Goldsmith, H. H., Klinnert, M. D., & Mrazek, D. A. (1999). Developmental models of infant and childhood temperament. *Developmental Psychology, 35*(1), 189.

Lewis-Morrarty, E., Degnan, K. A., Chronis-Tuscano, A., Rubin, K. H., Cheah, C. S., Pine, D. S., . . . Fox, N. A. (2012). Maternal Over-Control Moderates the Association between Early Childhood Behavioral Inhibition and Adolescent Social Anxiety Symptoms. *Journal of abnormal child psychology, 40*(8), 1363-1373.

Martel, M. M., & Nigg, J. T. (2006). Child ADHD and personality/temperament traits of reactive and effortful control, resiliency, and emotionality. *Journal of Child Psychology and Psychiatry, 47*(11), 1175-1183.

McLaughlin, K. A., Hatzenbuehler, M. L., Mennin, D. S., & Nolen-Hoeksema, S. (2011). Emotion dysregulation and adolescent psychopathology: A prospective study. *Behaviour research and therapy, 49*(9), 544-554.

Meeuwsen, M., Perra, O., van Goozen, S. H., & Hay, D. F. (2018). Informants' ratings of activity level in infancy predict ADHD symptoms and diagnoses in childhood. *Development and psychopathology*, 1-15.

Mervielde, I., & Asendorpf, J. B. (2000). Variable-centred and person-centred approaches to. *Advances in personality psychology, 1*, 37.

Mervielde, I., De Clercq, B., De Fruyt, F., & Van Leeuwen, K. (2005). Temperament, personality, and developmental psychopathology as childhood antecedents of personality disorders. *Journal of personality disorders, 19*(2), 171-201.

Mezulis, A. H., Priess, H. A., & Hyde, J. S. (2011). Rumination mediates the relationship between infant temperament and adolescent depressive symptoms. *Depression research and treatment, 2011*.

Muris, P., & Ollendick, T. H. (2005). The role of temperament in the etiology of child psychopathology. *Clinical child and family psychology review, 8*(4), 271-289.

Nigg, J. T. (2006). Temperament and developmental psychopathology. *Journal of Child Psychology and Psychiatry, 47*(3-4), 395-422.

Nigg, J. T. (2017). Annual Research Review: On the relations among self-regulation, self-control, executive functioning, effortful control, cognitive control, impulsivity, risk-taking, and inhibition for developmental psychopathology. *Journal of Child Psychology and Psychiatry, 58*(4), 361-383. doi:10.1111/jcpp.12675

Nigg, J. T., Goldsmith, H. H., & Sachek, J. (2004). Temperament and attention deficit hyperactivity disorder: The development of a multiple pathway model. *Journal of Clinical Child and Adolescent Psychology, 33*(1), 42-53.

Olino, T. M., Dougherty, L. R., Bufferd, S. J., Carlson, G. A., & Klein, D. N. (2014). Testing models of psychopathology in preschool-aged children using a structured interview-based assessment. *Journal of abnormal child psychology, 42*(7), 1201-1211.

Olson, S. L., Bates, J. E., Sandy, J. M., & Lanthier, R. (2000). Early developmental precursors of externalizing behavior in middle childhood and adolescence. *Journal of abnormal child psychology, 28*(2), 119-133.

Ozonoff, S., Iosif, A.-M., Baguio, F., Cook, I. C., Hill, M. M., Hutman, T., . . . Sigman, M. (2010). A prospective study of the emergence of early behavioral signs of autism. *Journal of the American Academy of Child & Adolescent Psychiatry, 49*(3), 256-266. e252.

Pedlow, R., Sanson, A., Prior, M., & Oberklaid, F. (1993). Stability of maternally reported temperament from infancy to 8 years. *Developmental Psychology, 29*(6), 998.

Pérez-Edgar, K., & Fox, N. A. (2005). Temperament and anxiety disorders. *Child and Adolescent Psychiatric Clinics, 14*(4), 681-706.

Pérez-Edgar, K., Schmidt, L. A., Henderson, H. A., Schulkin, J., & Fox, N. A. (2008). Salivary cortisol levels and infant temperament shape developmental trajectories in boys at risk for behavioral maladjustment. *Psychoneuroendocrinology, 33*(7), 916-925.

Pérez-Edgar, K. E., & Guyer, A. E. (2014). Behavioral inhibition: Temperament or prodrome? *Current behavioral neuroscience reports, 1*(3), 182-190.

Peters, J. L., Sutton, A. J., Jones, D. R., Abrams, K. R., & Rushton, L. (2008). Contour-enhanced meta-analysis funnel plots help distinguish publication bias from other causes of asymmetry. *Journal of clinical epidemiology, 61*(10), 991-996.

Peterson, R. A., & Brown, S. P. (2005). On the use of beta coefficients in meta-analysis. *Journal of Applied Psychology, 90*, 175.

Polanczyk, G. V., Salum, G. A., Sugaya, L. S., Caye, A., & Rohde, L. A. (2015). Annual Research Review: A meta-analysis of the worldwide prevalence of mental disorders in children and adolescents. *Journal of Child Psychology and Psychiatry, 56*(3), 345-365.

Polanin, J. R., & Snilstveit, B. (2016). *Converting between effect sizes*. Retrieved from

Prior, M., Smart, D., Sanson, A., & Oberklaid, F. (2000). Does shy-inhibited temperament in childhood lead to anxiety problems in adolescence? *J Am Acad Child Adolesc Psychiatry, 39*(4), 461-468. doi:10.1097/00004583-200004000-00015

Putnam, S. P., Rothbart, M. K., & Gartstein, M. A. (2008). Homotypic and heterotypic continuity of fine-grained temperament during infancy, toddlerhood, and early childhood. *Infant and Child Development: An International Journal of Research and Practice, 17*(4), 387-405.

Rettew, D. C., & McKee, L. (2005). Temperament and its role in developmental psychopathology. *Harvard review of psychiatry, 13*(1), 14-27.

GenericRevelle, W. (2019). An introduction to the psych package: Part II Scale construction and psychometrics. In: Personality Project.

Riley, R. D., Higgins, J. P., & Deeks, J. J. (2011). Interpretation of random effects meta-analyses. *Bmj, 342*, d549.

Rogers, C. E., Sylvester, C. M., Mintz, C., Kenley, J. K., Shimony, J. S., Barch, D. M., & Smyser, C. D. (2017). Neonatal amygdala functional connectivity at rest in healthy and preterm infants and early internalizing symptoms. *Journal of the American Academy of Child & Adolescent Psychiatry, 56*(2), 157-166.

Rothbart, M. K. (1981). Measurement of temperament in infancy. *Child development*, 569-578.

Rothbart, M. K., Ahadi, S. A., Hershey, K. L., & Fisher, P. (2001). Investigations of temperament at three to seven years: The Children's Behavior Questionnaire. *Child Development, 72*(5), 1394-1408.

Rothbart, M. K., Derryberry, D., & Hershey, K. (2000). Stability of temperament in childhood: Laboratory infant assessment to parent report at seven years. *Temperament and personality development across the life span*, 85-119.

Rothbart, M. K., Posner, M. I., & Kieras, J. (2006). Temperament, attention, and the development of self-regulation.

Sameroff, A. J., & Mackenzie, M. J. (2003). Research strategies for capturing transactional models of development: The limits of the possible. *Development and psychopathology, 15*(3), 613-640.

Sanson, A., Prior, M., & Kyrios, M. (1990). Contamination of measures in temperament research. *Merrill-Palmer Quarterly (1982-)*, 179-192.

Schwartz, C. B., Henderson, H. A., Inge, A. P., Zahka, N. E., Coman, D. C., Kojkowski, N. M., . . . Mundy, P. C. (2009). Temperament as a predictor of symptomotology and adaptive functioning in adolescents with high-functioning autism. *Journal of autism and developmental disorders, 39*(6), 842-855.

Shen, M. D., Kim, S. H., McKinstry, R. C., Gu, H., Hazlett, H. C., Nordahl, C. W., . . . Swanson, M. R. (2017). Increased extra-axial cerebrospinal fluid in high-risk infants who later develop autism. *Biological psychiatry, 82*(3), 186-193.

Shiner, R. L., Buss, K. A., McClowry, S. G., Putnam, S. P., Saudino, K. J., & Zentner, M. (2012). What Is Temperament Now? Assessing Progress in Temperament Research on the Twenty-Fifth Anniversary of Goldsmith et al.(). *Child Development Perspectives, 6*(4), 436-444.

Silk, J. S., Steinberg, L., & Morris, A. S. (2003). Adolescents' emotion regulation in daily life: Links to depressive symptoms and problem behavior. *Child development, 74*(6), 1869-1880.

Slagt, M., Dubas, J. S., Deković, M., & van Aken, M. A. (2016). Differences in sensitivity to parenting depending on child temperament: A meta-analysis. *Psychological bulletin, 142*(10), 1068.

Sonuga-Barke, E. J., & Halperin, J. M. (2010). Developmental phenotypes and causal pathways in attention deficit/hyperactivity disorder: potential targets for early intervention? *Journal of Child Psychology and Psychiatry, 51*(4), 368-389.

Stifter, C., & Dollar, J. (2016). Temperament and developmental psychopathology. In D. Cicchetti (Ed.), *Developmental Psychopathology* (pp. 546-607).

Stringaris, A., Maughan, B., & Goodman, R. (2010). What's in a disruptive disorder? Temperamental antecedents of oppositional defiant disorder: findings from the Avon longitudinal study. *Journal of the American Academy of Child & Adolescent Psychiatry, 49*(5), 474-483.

Thomas, A., & Chess, S. (1977). *Temperament and development*: Brunner/Mazel.

Viechtbauer, W. (2010). Conducting meta-analyses in R with the metafor package. *Journal of Statistical Software, 36*, 1-48.

Viechtbauer, W., & Cheung, M. W. L. (2010). Outlier and influence diagnostics for meta-analysis. *Research synthesis methods, 1*(2), 112-125.

Wass, S. V., Smith, C. G., Daubney, K. R., Suata, Z. M., Clackson, K., Begum, A., & Mirza, F. U. Influences of environmental stressors on autonomic function in 12-month-old infants: understanding early common pathways to atypical emotion regulation and cognitive performance. *Journal of Child Psychology and Psychiatry, 0*(0). doi:10.1111/jcpp.13084

Wehmeier, P. M., Schacht, A., & Barkley, R. A. (2010). Social and emotional impairment in children and adolescents with ADHD and the impact on quality of life. *Journal of Adolescent health, 46*(3), 209-217.

Wheeler Maedgen, J., & Carlson, C. L. (2000). Social functioning and emotional regulation in the attention deficit hyperactivity disorder subtypes. *Journal of clinical child psychology, 29*(1), 30-42.

Winder, B. M. (2013). *Temperament in Infants at Heightened Risk for Autism Spectrum Disorder.* (3564162 Ph.D.), Bryn Mawr College, Ann Arbor. Retrieved from https://search.proquest.com/docview/1400471892?accountid=11862 http://openurl.ac.uk/ukfed:kcl.ac.uk?url_ver=Z39.88-2004&rft_val_fmt=info:ofi/fmt:kev:mtx:dissertation&genre=dissertations+%26+theses&sid=ProQ:ProQuest+Dissertations+%26+Theses+A%26I&atitle=&title=Temperament+in+Infants+at+Heightened+Risk+for+Autism+Spectrum+Disorder&issn=&date=2013-01-01&volume=&issue=&spage=&au=Winder%2C+Breanna+M.&isbn=9781303128714&jtitle=&btitle=&rft_id=info:eric/&rft_id=info:doi/ ProQuest Dissertations & Theses A&I database.

Zentner, M., & Bates, J. E. (2008). Child temperament: An integrative review of concepts, research programs, and measures. *International Journal of Developmental Science, 2*(1-2), 7-37.