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A new look at the relations between attachment and intelligence

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ABSTRACT

In this paper we offer a new perspective on the relations between attachment and intelligence, a topic that has received relatively little attention in the recent decades of attachment research. Based on a review of relevant empirical work, a reanalysis of published data, and novel theoretical arguments, we advance a revised model of attachment and intelligence that challenges a number of widespread assumptions in the field. Specifically, we argue that attachment in infancy and childhood is influenced by general intelligence (with lower cognitive ability in ambivalent and disorganized categories compared with secure and avoidant ones), and that attachment states of mind in adulthood show a parallel pattern (with lower cognitive ability in preoccupied and unresolved/unclassifiable categories). The partially genetic correlation between parent and child intelligence gives rise to a previously unrecognized causal pathway linking parents' states of mind to children's attachment; parental intelligence also predicts aspects of sensitivity and mentalizing, and thus exerts an additional indirect influence on children's attachment. Our revised model suggests that intelligence likely contributes to the "transmission gap" between parental state of mind and child attachment; it also offers a novel (partial) explanation of the increased levels of parent–child concordance observed in older children.

Introduction

In this paper we offer a new perspective on the relations between attachment and intelligence—and, more broadly, on the place of individual differences in cognitive ability within attachment theory. This topic was intensively scrutinized by attachment scholars in the 1980s and early 90s (see de Ruiter & van IJzendoorn, 1993; van IJzendoorn et al., 1995), but has since faded as a conceptual and methodological concern in the field, despite a stream of relevant publications over the years (recent examples include Bizzi et al., 2021; Cropp et al., 2019; Gander et al., 2017; McCormick et al., 2016; O'Connor et al., 2019; Pace et al., 2017, 2020; Taubner et al., 2016).

The prevailing view in the literature—we call it the "standard model" for brevity—is that parents with a more secure state of mind with respect to attachment (evaluated via the Adult Attachment Interview [AAI; George et al.,1996] or related methods) foster the development of better cognitive skills in their children, an effect that seems to be partly mediated by their sensitivity as caregivers (Busch & Lieberman, 2010; Dagan et al., 2012). Accordingly, there is a small but positive association between children's attachment security and their intelligence scores (van IJzendoorn et al., 1995), which is typically assumed to reflect a beneficial effect of security on cognitive development (e.g., McCormick et al., 2016; West et al., 2013). In contrast, adult attachment states of mind are thought to be essentially unrelated to a person's cognitive ability, largely based on non-significant findings from the early psychometric studies of

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the AAI (e.g., Hesse, 2016). This model is summarized in Fig. 1.

In what follows we reconsider some common assumptions in the field, reanalyze published data, and examine them in light of the broader literature on intelligence. We focus specifically on the role of *general intelligence* (also known as *general cognitive ability* or simply *g*), usually formalized as a latent factor of cognitive speed and efficiency that affects performance across multiple specialized domains (e.g., verbal, visuospatial, memory, etc.) and is imperfectly measured by IQ scores from intelligence batteries (see Gottfredson & Saklofske, 2009; Jensen, 1998; Warne, 2020). General intelligence is important because it contributes to individual differences in virtually any kind of cognitive task, and because it carries the bulk of the predictive validity of intelligence tests (once *g* has been taken into account, the incremental contribution of specific abilities in predicting outcomes is typically small; see e.g., Gottfredson, 2002; Warne, 2020). In the remainder of the paper, we use the generic term "intelligence" to refer to *g* unless specified otherwise.

Based on our review and reanalysis of the relevant literature and data, we advance a contemporary perspective on the relationship between attachment and intelligence. Our argument can be summarized as follows:

1. As widely recognized in the literature, there is a small but robust positive correlation between intelligence and attachment security in children. The size of this effect has been underestimated in previous analyses, and is further attenuated by the psychometric limitations of both attachment and intelligence measures. Crucially, there are indications that the association between insecure attachment and lower intelligence is specific to the ambivalent and disorganized categories, and thus locally stronger than suggested by the overall correlation with security.
2. This association likely reflects a causal effect of intelligence on attachment, instead of—or in addition to—an effect of attachment on intelligence. We discuss reasons that lend credibility to this argument, and suggest plausible ways in which intelligence may specifically influence the development of ambivalent and disorganized attachment patterns.
3. We show that, contrary to the standard view in the literature, attachment states of mind in adolescents and adults show consistent associations with intelligence. In particular, there is a reliable positive correlation between intelligence and measures of overall coherence/security. In line with the findings of studies conducted in children, this effect appears to be driven by lower intelligence in adults with preoccupied and unresolved/unclassifiable (versus secure and dismissing) states of mind. These associations are similarly attenuated by psychometric limitations in both attachment and intelligence measures.
4. The association observed in adults likely reflects a causal effect of intelligence on both the construction of internal models and individual differences in conversational and discourse styles.
5. Intelligence levels of parents and children are correlated, owing to the combined effects of genetic and environmental factors. This correlation becomes stronger as children mature, while children's intelligence also shows a pattern of increasing heritability across the same developmental period. This suggests the existence of a previously unrecognized causal pathway linking parents' states of mind to children's attachment, as a result of correlated intelligence levels in parents and children.
6. There is considerable evidence that parental intelligence is a predictor of aspects of both sensitivity and mentalizing—two variables that partly mediate the association between parent and child attachment patterns. This represents another pathway by which intelligence may contribute to intergenerational concordance in attachment; it also suggests that the mediating role of sensitivity may have been somewhat overestimated in previous research.

As shown in Fig. 2, this argument leads to a revised model of the role of intelligence in the developmental and intergenerational dynamics of attachment (including the "transmission gap"; van IJzendoorn et al., 1995; Verhage et al., 2016). If the revised model is correct, cognitive ability is not a peripheral outcome of attachment-related processes but a pervasive influence that affects parents' caregiving behaviors as well as children's behavioral responses. An especially interesting implication of this model is that intelligence may contribute to the transmission gap between parental state of mind and child attachment (Verhage et al., 2016; Zeegers et al., 2017). Our model also suggests a partial explanation of the finding that parent–child concordance in attachment increases with children's age (Verhage et al., 2016). Furthermore, individual differences in cognitive ability may help explain the puzzling discovery that AAI states of mind seem to reflect generalized communication and discourse styles, and can be predicted from patients' and therapists' discourse about topics unrelated to attachment experiences (Talia et al., 2017, 2019a, 2019b, 2021). More broadly, we believe that there is much value in developing explicit causal models of the relations between attachment, intelligence, and other key variables such as caregiver sensitivity; we believe that such models will help promote more rigorous theorizing and inform future empirical work in this area.

Intelligence and attachment in children

Empirical patterns

Associations between intelligence and attachment security

The early decades of data on attachment and intelligence were synthesized in a meta-analysis by van IJzendoorn and colleagues (1995), which became a classic reference[1] and powerfully contributed to shape subsequent thinking on this issue. The meta-analysis found a correlation of 0.08 between intelligence and infant attachment security when intelligence was assessed with the Bayley Scales

[1] As of November 3, 2022, the article had garnered 508 citations in Google Scholar.

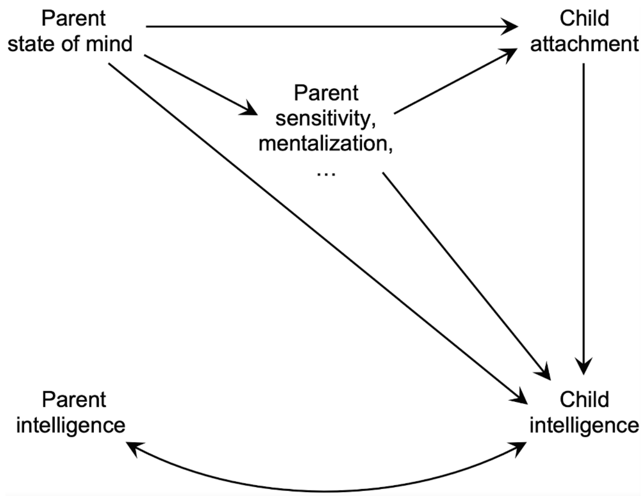

Fig. 1. The standard model of the relations between attachment and intelligence. Directed arrows represent causal effects; the double-headed arrow between parent and child intelligence represents a correlation due to shared genetic and environmental factors.

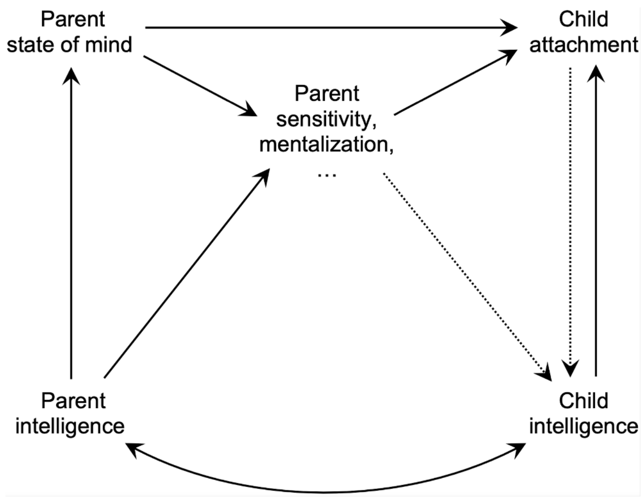

Fig. 2. An alternative model of the relations between attachment and intelligence. Directed arrows represent causal effects; dotted arrows indicate potential effects that (if present) are likely to wash out as children get older. The double-headed arrow between parent and child intelligence represents a correlation due to shared genetic and environmental factors.

of Infant Development (Bayley, 1993) at 1–2 years of age, and a correlation of 0.09 when intelligence was measured with other IQ tests (usually at 3 years or later). The aggregate correlation over both sets of measures was statistically significant and amounted to $r = 0.09$ (equivalent to $d = 0.18$); the individual studies had sample sizes between 15 and 72, and clearly lacked adequate power to detect effect sizes in this range.

It is important to realize that the authors took an extremely conservative approach to this meta-analysis: when a correlation had been identified as not significant, but the actual effect size had not been reported in the paper, it was imputed as zero. This is problematic because a full half of the effect sizes included in the overall meta-analysis of intelligence (13 out of 25) had gone unreported in the original papers. Clearly, replacing half of the effect sizes with zero can substantially deflate the meta-analytic results. Limiting the analysis to the reported effect sizes ($k = 12$) nearly doubles the estimated correlation to $r = 0.17$ (95 % CI [0.07, 0.28]), equivalent to $d = 0.35$ (95 % CI [0.14, 0.55]).[2] This is a reasonable approach, considering that (a) the studies that did not report effect sizes were based on small samples ($N = 18$–62) with limited statistical power, and could have failed to detect even nontrivial correlations as significant (up to 0.25-0.47 depending on sample size); and (b) of the reported effect sizes, less than half (5 out of 12) were

[2] All the meta-analytic estimates reported in this paper were based on random effects models and computed with module MAJOR in jamovi 1.6 (The jamovi project, 2021).

statistically significant, which argues against the presence of substantial publication bias. As we discuss below, there are psychometric reasons to believe that this revised estimate still understates the true association between intelligence and attachment security.

Subsequent research—using somewhat larger samples and a variety of assessment procedures—has collected more evidence that secure children score higher on intelligence tests (e.g., Jacobsen & Hofmann, 1997; Jacobsen et al., 1994; Spieker et al., 2003; Wellisch et al., 2011). As would be expected given the low power of most studies in this area, some negative findings have also been reported (e.g., Dubois-Comtois et al., 2011; Meins et al., 1998; Moss & St-Laurent, 2001). Other studies have found links between attachment security and better executive functioning in childhood (Bernier et al., 2012; Pallini et al., 2018; von der Lippe et al., 2010). These results are informative because executive functions overlap markedly with general intelligence, especially when one considers the shared variance among different kinds of executive tasks (Diamond, 2013; Friedman et al., 2006, 2008).

While attachment in infancy is assessed using behavioral observations—typically within the Strange Situation Procedure (SSP; Ainsworth et al., 1978)—older children are often tested with representational methods, such as story completion tasks or questionnaires. It is reasonable to wonder if representational measures of attachment may be more strongly associated with intelligence than their behavioral counterparts. At present, there are insufficient data to answer this question. The meta-analysis by van IJzendoorn et al. (1995) only included studies conducted with the SSP; half of the other studies reporting significant associations with intelligence or executive functioning employed behavioral observations (including the SSP; Bernier et al., 2012; Spieker et al., 2003; von der Lippe et al., 2010), while the other half used representational measures (Jacobsen & Hofmann, 1997; Jacobsen et al., 1994; Wellisch et al., 2011).

Associations between intelligence and specific attachment categories

Despite the overall correlation between intelligence and security, there is mounting evidence that the relevant dimension of comparison is not security *per se*. Instead, the association with lower intelligence seems to be limited to ambivalent and disorganized attachment, whereas avoidant children perform similarly to their secure peers. The first evidence pointing in this direction was reported by Mary Main (cited in Ainsworth et al., 1978), who noted that ambivalent (but not avoidant) infants tended to lag behind in measures of cognitive development. Lyons-Ruth and colleagues (1991, 1997) subsequently noted that disorganized infants were disproportionately more likely to lag behind their organized peers in cognitive development, as assessed with the Bayley scale. Of note, the strongest association with mental lag was observed for disorganized infants in the forced-ambivalent subgroup, albeit it did not reach significance given the small *N*s in the analysis (Lyons-Ruth et al., 1991). Consistent with these observations, van IJzendoorn and colleagues (1995) showed a significant correlation between the proportion of ambivalent children within a sample and the effect size of the association with intelligence (disorganization was not considered as a separate category).

In subsequent research, Stievenart and colleagues (2011) reported several negative correlations between disorganization (assessed with a story completion task) and cognitive performance; and even though their study only assessed adult attachment, Busch and Lieberman (2010) found evidence that children of mothers rated unclassifiable at the AAI had lower IQ scores than those of secure and dismissing mothers. Finally, a series of studies based on the largest dataset available to date (the National Institute of Child Health and Human Development [NICHD] Study of Early Child Care [SECC]) found that children classified as ambivalent, disorganized or "insecure/other" (i.e., lacking a coherent global behavioral strategy) based on a separation-reunion procedure at 3 years had lower IQ scores in middle childhood, and performed worse in mathematics and/or reading tasks (McCormick et al., 2016; O'Connor & McCartney, 2007; West et al., 2013). We are not aware of any evidence suggesting lower intelligence in avoidant children compared with their securely attached peers. A crucial implication of the empirical pattern described above is that focusing on the comparison between secure and insecure children will underestimate the links between attachment and intelligence, and further reduce the power of individual studies.

A Note on the child attachment Interview

A number of studies in this area have employed the Child Attachment Interview (CAI; target et al., 2007), an interview designed for use in middle and late childhood and modeled on the scoring criteria of the AAI. Although some of those studies found evidence of higher IQ in secure children and adolescents (O'Connor et al., 2019; Sawyer, 2004), most of the research conducted with the CAI has failed to find significant associations between attachment and intelligence (Bizzi et al. 2021; Pilley, 1999; Shmueli-Goetz et al., 2008; Target et al. 2003).

Notably, all of these studies have focused on the comparison between secure and insecure children, and none of them has specifically tested the performance of preoccupied and/or disorganized children. Crucially, most studies of adolescents and adults conducted with the AAI also failed to detect omnibus differences across categories or between secure and insecure individuals (partly owing to the low power of individual samples). However, as we discuss below, contrasting the secure and dismissing categories with the preoccupied and unresolve/unclassifiable categories yields clear evidence of lower IQ in the latter. While the CAI studies we reviewed did not report enough information to run the same kind of reanalysis, we suggest that their largely null results should be interpreted in the context of the AAI findings that discussed below, given the conceptual correspondence between the scoring and classification rules of the CAI and AAI.

Associations between parental states of mind and Children's intelligence

Before concluding this section, we briefly consider the evidence linking parental states of mind to children's intelligence. In a study by Busch and Lieberman (2010), mothers' coherence of mind scores on the AAI predicted higher IQ in their children. This association was partly mediated by maternal sensitivity (see also Dagan et al., 2012). Crandell and Hobson (1999) used a questionnaire version of the AAI (the AAIQ; Crandell et al., 1997) and found that the children of secure mothers had higher IQ scores. In contrast, Pace et al.

(2015) found no significant correlations between AAI scales in adoptive mothers and IQ in their children, which is consistent with the idea that the associations seen in biological pairs may be largely due to genetic confounding (we discuss this further below). However, both their study and that by Crandell and Hobson were based on rather small samples ($N = 30$ and 35, respectively), limiting the inferences that can be drawn.

Psychometric issues

Reliability and validity

To properly interpret the empirical findings in this area, it is important to consider the psychometric limitations of the tests used to measure attachment and intelligence. The *reliability* of a test is the proportion of variance that can be regarded as signal rather than noise (i.e., measurement error). The *validity* of a test is the extent to which it measures the construct that it is purported to measure, and can be quantified by the correlation between the test and the target construct. Reliability puts a ceiling on validity; a test can be reliable but invalid if it measures something else in addition to (or instead of) the target construct. The observed association between two constructs will be attenuated by unreliability in the tests. A lack of validity usually has the same deflationary effect, except in special cases where the invalid portions of the variance introduce spurious correlations between the tests.

Measures of attachment

The main limitation of attachment measures is their low reliability, especially when individuals are sorted into discrete categories as in 2-way (secure vs insecure), 3-way (secure, avoidant, ambivalent), and 4-way classifications (which include a disorganized/unclassifiable category). For example, the typical inter-rater reliability of 4-way classifications in the CAI is in the 0.50-0.70 range (Cohen's κ), even if some studies have reported values of 0.80 or more (see Bizzi et al., 2021; Target et al., 2003; Schmueli-Goetz, 2008). Test-retest reliabilities over a short period of time (<6 months) are considerably lower: for secure vs insecure classifications (which are more stable than 4-way classifications) across assessment methods, they average 0.45 considering all ages from infancy to young adulthood, and only 0.36 in infancy (Pinquart et al., 2013). Accordingly, the observed meta-analytic correlation between secure state of mind in parents and secure attachment in children is $r = 0.25$, but the effect increases to $r = 0.52$ after correcting for attenuation (Verhage et al., 2016).

Measures of intelligence

In contrast with attachment measures, full-scale IQ scores from standard intelligence batteries are extremely reliable, in childhood as well as adulthood (test–retest reliabilities greater than 0.90; see Jensen, 1998; Roid, 2003; Wechsler, 2008, 2014). The validity of full-scale IQ is also high; correlations with the latent *g* factor are typically around 0.85-0.90 (Jensen, 1998). However, full-length batteries are very time consuming, and many studies of attachment in childhood use either individual scales/subtests (e.g., Jacobsen & Hofmann, 1997; Jacobsen et al., 1994; McCormick et al., 2016; Meins & Russell, 1997; Moss & St-Laurent, 2001) or combinations of a few subtests (e.g., Bizzi et al., 2021; Moss & St-Laurent, 2001; Stievenart et al., 2011; O'Connor & McCartney, 2007; Shmueli-Goetz et al., 2008; West et al., 2013). Full-scale IQ assessments are rare exceptions in this literature (e.g., Wellisch et al., 2011). Of course, IQ scores based on abbreviated batteries and individual subtests are not as reliable as their full-scale counterparts; even more importantly, the scores of individual scales (e.g., vocabulary, matrix reasoning) do not just reflect general intelligence, but also specific abilities and/or performance in broad cognitive domains (e.g., verbal, visuospatial). In the typical subtest of an intelligence battery, *g* makes up less than half of the reliable variance (Jensen, 1998). If general intelligence if the construct of interest, the validity of individual scales may be considerably lower than their reliability, further contributing to attenuate the observed relations with attachment.

An especially dramatic example of questionable validity in the face of excellent reliability is provided by Bayley's "mental scales", which are probably the most widely used tests of intelligence in infancy. Although these scales have test–retest reliabilities around 0.90 (Bayley, 1993; Hua et al., 2019), Bayley scores measured before 2 years of age correlate only weakly with intelligence in childhood, and show almost no predictive power with respect to adult intelligence (Bornstein & Sigman, 1986; Cardon & Fulker, 1991; Petrill et al., 2004; Slater, 1995; Yu et al., 2018). The classic explanation of this phenomenon was that cognitive abilities undergo a drastic reorganization in the transition from infancy to childhood; however, it later became apparent that alternative measures based on infants' selective attention predict adult intelligence just as well as IQ scores in early childhood (see Fagan et al., 2007; Slater, 1995). The most plausible interpretation is that the Bayley scales administered before 2 years of age have poor validity as measures of infants' general intelligence (*g*), but become increasingly valid starting from the version for 2-year-olds (Slater, 1995). Note that in van IJzendoorn et al.'s (1995) meta-analysis, most of the studies administered the Bayley scales around 2 years of age, which explains why their aggregate effect size was comparable to that obtained from standard IQ tests (see Tables 1 and 2 in van IJzendoorn et al., 1995).

Implications

In sum, the true extent of the associations between intelligence and attachment is obscured by the low reliability of categorical attachment measures—especially in the case of 4-way classifications—and by the uneven psychometric performance of the various tests used to measure intelligence in attachment studies. As a result, the statistical power of individual studies is reduced and observed correlations are attenuated to a substantial degree. To illustrate: assuming a test–retest reliability of 0.36 for attachment and 0.90 for intelligence (see above), the overall correlation between security and intelligence that we estimated from the meta-analysis by van IJzendoorn and colleagues (1995) would increase from $r = 0.17$ to $r = 0.30$ (equivalent to $d = 0.63$ assuming equal-sized groups).[3] While this effect is far from trivial, one should remember that it still underestimates the specific associations of intelligence with ambivalence and disorganization.

Causal interpretation

Alternative causal hypotheses

What explains the relation between the quality of children's attachment to parents and their cognitive ability? In a recent paper, Talia and colleagues (2021) singled this out as one of the central unanswered questions in the field. Attachment scholars have proposed several potential pathways through which the quality attachment may indirectly affect children's cognitive performance. For example, trusted and trustful caregivers may be more successful in teaching securely attached children, who may also receive additional cognitive stimulation because the enjoy better relationships with teachers and peers. Alternatively, secure attachment may promote cognitive competence by fostering exploration and mastery of the environment (i.e., the secure-base concept, Blatz, 1944), a positive self-concept, and/or enhanced metacognitive monitoring; more narrowly, secure children may perform better at cognitive tests because they experience less test anxiety and are more able to cooperate with the examiner (e.g., Jacobsen et al., 1994; van IJzendoorn et al., 1995; West et al., 2013). We note that many of these hypotheses assume a straightforward positive correlation between security and intelligence, and struggle to explain why the observed association appears specific to ambivalence and disorganization. From this perspective, the most plausible candidate is the hypothesis that exploration mediates the effect of attachment on intelligence, considering the active exploration of avoidant children and the inhibited exploration of ambivalent ones (Ainsworth et al., 1978).

Despite the overwhelming emphasis on the possible effects of attachment on intelligence, some investigators have long been aware that the causal arrow might run in the opposite direction. In their landmark *meta*-analysis, van IJzendoorn and colleagues (1995) cautioned:

> "[…] We should not exclude the possibility that cognitive development influences the development of attachment relationships. […] Children who are cognitively more advanced, may be better able to convey their attachment needs and emotions to their parents who in turn respond more sensitively" (p. 117).

However, this possibility has not been explored in the literature, with the exception of a study by Stievenart and colleagues (2011). Using a two-wave longitudinal model, the authors found evidence of reciprocal relations between attachment (measured with a story completion task) and cognitive abilities over time. This particular study has some important limitations: in addition to measuring verbal and reasoning IQ with single subtests, the authors used verbal and reasoning scores as separate predictors in the model, thus effectively removing the variance corresponding to general intelligence (i.e., the shared variance between verbal and reasoning abilities). They also used security and disorganization (which were strongly negatively correlated) as separate predictors; the resulting partial effects must be interpreted with care, because they exclude the large proportion of variance shared between disorganization and (in)security. This likely explains their puzzling finding of a positive predictive relation between disorganization and verbal IQ, despite generally negative zero-order correlations between intelligence and disorganization. Nevertheless, the study is noteworthy because the authors explicitly acknowledged the possibility that the elaboration of attachment-related internal working models (IWMs) might depend on children's cognitive capacities; for example, they suggested that higher intelligence may allow children to construct "open" working models that are more flexible and adaptable to changing circumstances.

In the remainder of this section, we argue that the hypothesis of "reverse causality" from intelligence to attachment is quite plausible, and can readily account for the existence of specific associations with certain patterns of parent–child attachment. We first discuss why it is wise to consider intelligence as a plausible causal influence on developmental outcomes, and present some cautionary tales of putative environmental effects on children's intelligence that have turned out to reflect reverse causality and/or confounding by parental intelligence and socioeconomic status (SES). We then advance some novel hypotheses on the role of intelligence in the development of ambivalent and disorganized forms of attachment.

Intelligence: Cause or Effect?

General intelligence is one of the most important dimensions of individual differences, and lies at the center of a vast nexus of effects—not just on academic and job performance (Gottfredson, 2002; Jensen, 1998; Warne, 2020), but also on mental health (Caspi & Moffitt, 2018; Caspi et al., 2020; Hill et al., 2019; Whitley et al. 2011), physical health (Gottfredson, 2004), and even mortality (Arden et al., 2016; Calvin et al., 2011; Christensen et al., 2016). In all these domains, the data indicate that intelligence acts at least partially as a causal factor, influencing outcomes through its effects on cognition and behavior. From a neurobiological perspective, the once-elusive neural correlates of intelligence are increasingly well understood, and include heritable variables such as brain size, cortical thickness, white matter integrity, and energetic efficiency of brain signaling (see Basten et al., 2015; Deary et al., 2010, 2021;

[3] The disattenuation formula for correlations is $r_c = r/\sqrt{r_{XX}r_{YY}}$, where r_c is the corrected correlation between X and Y, r is the raw correlation, and r_{XX} and r_{YY} are the reliabilities of the two variables. The conversion formula from r to d for equal-sized groups is $d = 2r/\sqrt{1-r^2}$ (see Schmidt & Hunter, 2014).

Table 1
Correlations Between Intelligence and Coherence/Security of Attachment States of Mind.

Study	Sample	*N*	Attachment measure	Intelligence measure	*r*
Crowell et al. (1996)	Adults	53	AAI - coherence of transcript	Full-scale IQ	0.42
Taylor et al. (2008)	Adults (HFA)	20	AAI - coherence of transcript	Full-scale IQ (brief)	0.41
				Verbal IQ (brief)	0.36
				Performance IQ (brief)	0.25
			AAI - coherence of mind	Full-scale IQ (brief)	0.25
				Verbal IQ (brief)	0.30
				Performance IQ (brief)	0.19
Zajac & Kobak (2009)	Adults	124	AAI - secure prototype (Q-sort)	Vocabulary subtest	0.23
Hallin et al. (2012)	Adolescents	78	AAI - coherence of mind	Full-scale IQ	0.29[a]
				Verbal IQ (subtests)	0.33[a]
				Performance IQ (subtests)	0.12[a]
Scharfe (2002)	Adolescents	127	FAI - secure prototype score	Full-scale IQ	0.13
				Verbal IQ	0.17
				Performance IQ	0.06
Pace et al. (2018)	Adolescents	80	FFI - secure prototype score	Verbal IQ	0.56[b]
Pace et al. (2020)	Adolescents	110	FFI - coherence	Verbal IQ (subtests)	0.08
			FFI - secure prototype score	Verbal IQ (subtests)	0.08

Note. AAI = Adult Attachment Interview. AAP = Adult Attachment Projective. FAI = Family Attachment Interview. FFI = Friends and Family Interview. HFA = high-functioning autism.
[a] The correlation was pooled across the two subsamples of the study (preterm and full-term).
[b] The correlation was pooled across the two subsamples of the study (adopted and non-adopted).

Table 2
Intelligence Differences: Secure and Dismissing vs Preoccupied and Unresolved/Unclassifiable Categories.

Study	Sample	*N*	Attachment measure	Intelligence measure	*d*
Bakermans-Kranenburg & van IJzendoorn (1993)	Adults	83	AAI	Full-scale IQ[a]	0.23[a]
				Verbal IQ (subtests)	0.11
				Performance IQ (matrices)	0.34
Crowell et al. (1996)	Adults	53	AAI	Full-scale IQ	0.61
Rosenstein & Horowitz (1996)	Adolescents	59	AAI	Full-scale IQ	0.24
				Verbal IQ	0.21
				Performance IQ	0.24
Delvecchio et al. (2013)	Adults	101	AAP	Full-scale IQ	0.52
				Verbal IQ	0.55
				Performance IQ	0.32
Gander et al. (2017)	Adolescents	79	AAP	Verbal IQ (subtests)	−0.32

Note. Positive values of Cohen's *d* indicate higher intelligence in secure and dismissing participants compared with preoccupied and unresolved ones. AAI = Adult Attachment Interview. AAP: Adult Attachment Projective.
[a] The effect size for the full-scale IQ was estimated as the average of the effects for verbal and performance IQ.

Geary, 2018; Lee et al., 2019; Nave et al., 2019; Pietschnig et al., 2015; Ritchie et al., 2015).

It is a well-known finding that intelligence becomes more heritable across the lifespan; the proportion of variance explained by additive genetic factors (*narrow-sense heritability*) goes from 10 to 20 % in infancy to 30–40 % in childhood, further increasing to 50–60 % in adolescence and 60–70 % in young adulthood. The weight of shared environmental factors—that is, the family-level factors that make siblings similar to one another—decreases accordingly, from up to 50 % of the variance in early childhood to 10 % or less in adulthood (Bartels et al., 2002; Haworth et al., 2010; Petrill et al., 2004; Rice et al., 1988).[4] Note that these figures should not be over-interpreted; when proportions of variance are translated into real-world effects on the same scale as the phenotype (e.g., IQ units, instead of the "squared IQ units" of the variance), apparent differences can shrink to a substantial degree. For example, if 60 % of the variance is genetic and 10 % is due to the shared environment, the impact of the shared environment is not one sixth of that of genes but about 40 % as large (the square root of 1/6th; for a detailed explanation see Del Giudice [2021]). Likewise, the age-related growth in the influence of genetic factors is not as dramatic as it may appear from the heritability figures: to illustrate, a fourfold increase in heritability corresponds to a twofold increase in the real-world impact of genes. Even with this caveat, it is clear that genetic differences play an important role in the development of intelligence (Deary et al., 2021), and that the initial effects of the family environment tend wane in influence as children grow up (for a striking illustration, see the recent long-term adoption study by Willoughby et al. [2021]).

Against this backdrop, it is important to exert caution when dealing with putative environmental determinants of intelligence.

[4] The precise value of the estimates can vary quite a bit depending on how intelligence and its development over time are modeled in the analysis; see e.g., Bartels et al. (2002).

What looks like a causal effect of variable X on intelligence may instead reflect reverse causality (intelligence affects X) or confounding (a third variable affects both X and intelligence). Genetic confounding is a particularly pressing concern, given that (a) a parent's intelligence affects his/her behavior, thus contributing to shape the child's environment; and (b) shared genetic factors contribute to determine both the parent's and child's intelligence (see Hart et al., 2021). Even in non-biological dyads, parental and child intelligence are still correlated through environmental effects (especially in infancy and childhood), opening up a potential confounding pathway.

Consider the widely accepted idea that maternal smoking during pregnancy has a damaging impact on neurodevelopment and leads to lower intelligence in children. While there is a robust association between smoking and children's intelligence, it is also the case that less intelligent and educated mothers are disproportionately more likely to smoke during pregnancy. As it turns out, controlling for parental IQ and education (either directly or using sibling controls) makes the association all but disappear, as would be expected if the apparent causal effect of smoking was a case of complete confounding (Arrhenius et al., 2021; Batty et al., 2006). Breastfeeding is another environmental factor that is often assumed to have a powerful effect on children's intelligence. Again, controlling for parental IQ and education dramatically shrinks the size of the association, although there may be still room for a small residual effect (Boutwell et al., 2018; Der et al., 2006; Girard et al., 2017). Even the association between lead exposure and lower intelligence is strongly confounded by parental IQ and education, to the point where it is hard to determine if small doses of lead in the blood have any detrimental effect at all (Van Landingham et al., 2020; Wilson & Wilson, 2016). As a final example, consider the robust statistical relation between obesity and lower IQ. While this finding is almost always interpreted as evidence that obesity has a detrimental impact on intellectual functioning, there is overwhelming evidence that the arrow of causality runs in the opposite direction, from intelligence to obesity (see Kanazawa, 2014).

In conclusion, environmental effects on intelligence and IQ undoubtedly exist, but—with the exception of clear-cut examples such as schooling (Ritchie & Tucker-Drob, 2018)—they are often hard to identify and quantify with confidence. At the same time, many plausible environmental effects on intelligence have turned out to be instances of confounding or reverse causality. In our view, this supports our assumption that intelligence is a likely factor in the development of attachment. To be clear, we are *not* denying the possible existence of effects in the opposite direction, for example mediated by differences in exploration. Effects of this sort are especially plausible during infancy and early childhood, when the impact of the family environment on intelligence is maximal; for the same reason, they are likely to wash out as children transition to middle childhood and adolescence. In the model displayed in Fig. 2, the vertical dotted arrow on the right represents this kind of potential, likely transitory effect on the development of intelligence.

Possible causal mechanisms

As suggested by Stievenart and colleagues (2011), intelligence plausibly contributes to attachment development by influencing the construction and utilization of the child's internal working models (IWMs). A key function of IWMs is to generate predictions about the caregiver's behavior, and about the likely outcomes of alternative events and courses of action (see Bretherton & Munholland, 2016; Bretherton, 1990; see also Crittenden, 1990). A common (if tacit) assumption in attachment theory is that the content of the child's attachment-related IWMs is essentially determined by the caregiver's objective behavior toward the child. However, the construction of the child's IWMs must involve at least two components that jointly determine the end result, namely the parent's behavior *and* the child's perception and interpretation of that behavior.

This distinction is especially consequential when the caregiver's behavior does not follow a simple, consistent, and easily predictable pattern, but instead is highly contingent on contextual factors and/or on the caregiver's current mental states. In such cases, the child's interpretation of the caregiver's behavior should depend, at least in part, on the child's ability to track and understand the contingencies that modify the caregiver's response, correctly identify the caregiver's mental states, and take his/her perspective on events and situations. (Relevant information may become available through direct observation, but also through verbal and nonverbal communication between the child and the caregiver.) These tasks are cognitively demanding and depend significantly on the child's general intellective resources; for example, mindreading and perspective-taking skills are significantly correlated with IQ in both children and adults (e.g., Baker et al., 2014; Kurdek, 1977; Rajkumar et al., 2008; Tarshis & Shore, 1991). In turn, internal models help individuals interpret the meaning of others' behavior, make predictions regarding their behavior in the future, plan a behavioral response based on these predictions, and cognitively manipulate potential alternative courses of action (Crittenden, 1990, 1999). Most likely, the effectiveness of these processes depends in part on the child's cognitive resources.

In brief, we propose that—all else being equal—more intelligent children will tend to construct more complex and accurate models of the caregiver, and that these models will tend to be more predictive and/or integrated than those of their less cognitively capable peers. In the presence of certain patterns of contingencies in parental behavior, differences in the predictive accuracy and integration of children's IWMs may "tip the scale" by favoring (or preventing) the development of ambivalence and disorganization. To be clear, we are not suggesting that intelligence *directly* determines the content and functional significance of IWMs; research has clearly demonstrated that children with intellectual disability or genetic risk thereof are able to direct attachment behaviors (e.g., proximity seeking, contact maintenance) towards their caregivers and can form secure attachment relationships, even if at somewhat lower rates than normally developing children (e.g., Dissanayake & Crossley, 1996; Naber et al., 2007; Rutgers et al., 2004; Serafica & Cicchetti, 1976; Teague et al., 2017; see also Haltigan et al., 2011). Rather, our proposal is that, when the caregiver's behavior is variable and hard to predict, more intelligent children have a better chance of understanding the underlying reasons and contingency patterns, and hence making accurate predictions that will affect the content of IWMs; they can also use their IWMs more effectively to organize their behavioral responses to the caregivers. As noted by an anonymous reviewer, another possibility is that low-IQ children tend to be more behaviorally difficult and lower in self-regulation abilities, and as a result elicit less sensitive behaviors from their caregivers. While we acknowledge this alternative hypothesis (especially at the very low end of the IQ distribution), here we focus on children's cognitive processing of attachment-related information as the main causal link between intelligence and attachment. In our view, this perspective shows better conceptual convergence with findings on attachment states of mind in adults (see below), and affords more specificity in the analysis of attachment categories beyond secure vs insecure.

Consider the case of ambivalent attachment. The core feature of ambivalent children's IWMs is *uncertainty* about their caregiver, who is perceived as inconsistently (and unpredictably) available (Cassidy & Berlin, 1994). A child who is better able to explain the variability in the caregiver's behavior—and thus make sense of otherwise confusing lapses in availability—will reduce this uncertainty, leading to a higher sense of predictability and a perception of the caregiver as comparatively more consistent. In this manner, higher intelligence may tip the scale toward security, whereas lower intelligence may tip the scale toward ambivalence, even when faced with the same behaviors by the caregiver.

In the case of disorganization, the underlying psychological process is assumed to involve disturbances and *contradictions* in the attachment system and the IWMs that govern it (Duschinsky & Solomon, 2017; Main & Solomon, 1990). Again, differences in general intelligence can tip the scale in either direction, by facilitating or hindering the construction of an integrated predictive model of the caregiver. It is well known that neurological abnormalities can give rise to disorganized and disoriented behaviors in infants and children (Pipp-Siegel et al., 1999; Sprangler et al., 1996); more broadly, and consistent with a role for mild cognitive difficulties, prematurity and poor emotional regulation at birth predict subsequent attachment disorganization (Padrón et al., 2014; van IJzendoorn et al., 1999). If higher intelligence permits the construction of more integrated and coherent IWMs, the association between lower intelligence and disorganization should be especially pronounced in disorganized subtypes marked by contradictory behavioral strategies (mixed avoidance and resistance) or by the absence of a coherent strategy. The limited available data seem consistent with this prediction (McCormick et al., 2016; O'Connor & McCartney, 2007).[5]

In contrast with the inconsistent, contradictory, and confusing caregiver behaviors associated with ambivalence and disorganization, children tend to become securely attached when their caregivers are consistently available, and avoidantly attached when they are consistently unavailable. The high consistency (and context-independence) of these caregivers' behavior makes them easy to predict using relatively simple IWMs, and thus does not pose any particular cognitive challenges to their children. Thus, children of all intelligence levels remain in the secure and avoidant categories when caregiving is consistent; but with inconsistent or unpredictable caregivers, children with lower intelligence tend to remain in the ambivalent and disorganized categories, whereas children with higher intelligence tend to move toward security and avoidance. As a result, the *average* intelligence of ambivalent and disorganized children will be lower than that of their secure and avoidant peers.

In sum, the hypothesis of "reverse causality" from intelligence to attachment can easily account for the specific associations between ambivalence, disorganization, and lower intelligence. Of note, many of the variables that have been found to statistically mediate the relation between attachment and cognitive performance can instead be plausibly viewed as manifest indicators of children's and/or parents' intelligence. Examples include engagement in challenging cognitive tasks, quality of maternal assistance during those tasks, maternal cognitive stimulation, parent encouraging of school, communication ability, and executive functioning (see McCormick et al., 2016; O'Connor & McCartney, 2007; West et al., 2013). According to our hypothesis, these variables correlate with both attachment and cognitive performance not so much because they causally mediate the association between the two constructs (though partial mediation may plausibly occur in some cases), but because they share variance with individual differences in the intelligence of children and/or their parents.

The issue of longitudinal stability

Contradicting the early assumption that attachment representations formed in infancy tend to persist throughout a person's life, the evidence clearly shows that both attachment security and insecure classifications are only moderately stable over time, with small and often non-significant correlations between infancy and adolescence/early adulthood (Fraley, 2002; Fraley & Roisman, 2019; Groh et al., 2014; Piquart et al., 2013). While stability estimates in longitudinal studies are necessarily deflated by the low reliability of attachment measures (see above), the general pattern is inconsistent with strong, deterministic, and temporally invariant influences on attachment.

As we stressed in the previous sections, our hypothesis that intelligence contributes to the development of attachment does not imply that attachment is a simple deterministic function of cognitive ability. The core idea is that intelligence contributes to probabilistically "tip the scale" toward certain kinds of attachment representations, in combination with myriad other factors; moreover, we do not postulate a simple relation between intelligence and security, given that avoidance is also associated with higher intelligence. Crucially, intelligence itself is far from entirely invariant over time, and shows only moderate stability from infancy to adulthood (Fagan et al, 2007; Petrill et al., 2004; Yu et al., 2018), partly reflecting the developmental changes in genetic structure discussed earlier. Hence, our hypothesis does *not* predict that attachment representations should remain stable throughout the life course.

[5] Note that, even if disorganized behaviors disappear or become more coherently organized following infancy (often being replaced by "controlling" strategies), the children's underlying IWMs tend to remain disorganized and poorly integrated, as shown by the children's narratives in response to story completion tasks (see Main et al., 1985; Solomon et al., 1995).

Intelligence and attachment states of mind in adults

Empirical patterns

The role of narrative coherence in the AAI

The scoring system of the AAI is primarily based on the coherence and quality of discourse shown by participants while recounting and reflecting on their attachment experiences, as judged against the Gricean conversational maxims of *quantity*, *quality*, *manner*, and *relevance* (Crowell, 2021; Hesse, 2016). Interviews classified as secure/autonomous display high levels of coherence and cooperation with the interviewer; discourse is conversationally balanced, vivid and to the point. Interviews classified as dismissing tend to show idealization or derogation of the parents, lack of episodic detail and specific memories, as well as contradictions between a generalized positive evaluation of one's attachment experience and episodic descriptions of cold, rejecting behaviors by one's parents. These features of dismissing interviews can be framed as violations of the Gricean conversational maxims of quantity and quality. Preoccupied interviews are characterized by intense manifestations of anger toward the parents, formulaic responses that include jargon or "psychobabble", and passivity of discourse—a broad category that includes nonsense words, vague expressions, wandering off topic, incomplete sentences, and conversational slips into confusion between the self and the parent. These forms of incoherence can be viewed as violations of the maxims of relevance, quantity, and manner.

Interviews of participants who report attachment-related trauma of loss and/or abuse are classified as unresolved (in addition to a secondary organized classification of secure, dismissing, or preoccupied) if confusion and disorganization in the narrative emerge when these topics are discussed. Unresolved narratives are characterized by lapses in reasoning and/or discourse (e.g., a belief that a dead person is still alive). In principle, and analogous to the coding process for behavioral indicators of infant disorganization in the SSP, even a single lapse can be sufficient to classify an interview as unresolved; in practice, however, multiple indicators of unresolved loss/abuse tend to co-occur in the same interviews (see Bakkum et al., 2022). Unclassifiable interviews (*cannot classify* or CC) display extremely low levels of global coherence, usually because they display poorly integrated mixtures of dismissing and preoccupied strategies (Hesse, 1996). In most studies using the AAI, unclassifiable interviews are grouped with transcripts classified as unresolved and not analyzed separately; this is far from ideal, as the underlying cognitive processes are likely to differ in important ways (see e.g., the "Hostile-Helpless" patterns of discourse described by Lyons-Ruth et al. [2005]). The overall coherence of a transcript is summarized by a *coherence of transcript* rating (and the closely related *coherence of mind*). Coherence scores correlate almost perfectly with the interview's degree of similarity to the secure prototype; in the scoring system of the AAI, then, "coherence" and "security" are basically synonymous (Crowell, 2021).

Associations between intelligence and Coherence/Security

In the years following the introduction of the AAI, the prominent role played by discourse coherence in the coding system raised plausible concerns about the contribution of individual differences in cognitive ability. For example, de Ruiter & van IJzendoorn (1993) noted:

> "[…] it is not inconceivable that intelligence may be in some cases related to the quality of a parent's internal working model of attachment. We speculate that an individual with ample intellectual resources may be able to use these resources in such a way that his/her internal working model of attachment would be relatively open to new information and experiences. Intelligence might thus facilitate the development of a secure internal working model, even in individuals who have been exposed to rejecting and/or inconsistent parents in childhood […]. However, one could also validly argue the opposite, namely that superior intelligence might increase the likelihood of intellectual defenses, such as rationalization, to stabilize an insecure internal working model by defending against processing information that is incongruent with the existing model." (p.535).

Bakermans-Kranenburg and van IJzendoorn (1993) raised similar considerations:

> "[…] AAI classifications may be influenced by differences in intelligence. One of the most important criteria for classifying a transcript as secure or insecure is the coherence of the interview. […] The coding system defines and operationalizes coherence in terms of Grice's (1975) maxims for optimal discourse: quality, quantity, relation, and manner. In a formal sense, coherence indicates connectedness of thought such that parts of the discourse are clearly related and form a logical whole. […] Subjects who are cognitively able to detect and avoid logical inconsistencies in their narratives may erroneously be rated as more secure emotionally. Differences in cognitive abilities may also play a role in the production of rich and convincing as opposed to poorly verbalized interviews […]". (p. 871).

Nevertheless, the first psychometric studies of the AAI failed to show significant associations between attachment states of mind and intelligence scores (Bakermans-Kranenburg & van IJzendoorn, 1993; Sagi et al., 1994). The study by Crowell and colleagues (1996) was a partial exception: while the omnibus test across 4-way categories was non-significant, the authors found higher intelligence in secure vs insecure participants and in dismissing vs preoccupied ones. Unsurprisingly, all of these studies were based on fairly small samples ($N = 53$–83) and hence underpowered to detect small to moderate associations; the small sample size also cast doubts on the robustness of Crowell et al.'s significant findings (e.g., the study included only four preoccupied participants). Based on the initial negative results, most researchers came to share the mainstream view that attachment states of mind are essentially unrelated to cognitive ability (e.g., Hesse, 2016).

Despite this consensus, studies that have correlated intelligence with coherence and/or security scores have found a remarkably consistent pattern of positive associations. Table 1 displays all the published correlations of this kind that we were able to recover from studies using either the AAI or conceptually related measurement tools, such as the Adult Attachment Projective (AAP; George et al., 1997) and the Friends and Family Interview (FFI; Steele & Steele, 2005). Although we caution readers that we are not conducting a formal systematic review and meta-analysis of the literature, it can be quite informative to estimate aggregate effects by computing meta-analytic averages across subsets of related studies. All estimates were based on random-effects models; we limited our analyses to subsets of at least three studies ($k \geq 3$).

For studies employing the AAI, the mean correlation between full-scale IQ and coherence of transcript (or coherence of mind, when the former was not reported) was estimated at $r = 0.36$ (95 % CI [0.22, 0.50]; $k = 3$; $N = 151$). Across attachment measures, the mean correlation of security scores with verbal IQ was $r = 0.26$ (95 % CI [0.05, 0.48]; $k = 4$; $N = 441$). The overall pattern was surprisingly consistent, and associations were positive in all the studies we could locate (Table 1). Publication bias is extremely unlikely to explain these findings, since (a) intelligence was not the primary variable of interest in any of these studies, and (b) most of the correlations in Table 1 were statistically non-significant when considered individually. In total, the data on the coherence/security of attachment states of mind in adults mirror those on security in children; in both cases, there is a positive overall correlation with intelligence that may mask specific associations with particular forms of insecurity.

Associations between intelligence and specific categories

The findings of lower intelligence in ambivalent and disorganized children relative to secure and avoidant children (see above) suggest the parallel hypothesis that, in adults, the correlation with security may be largely accounted for by a pattern of lower intelligence in preoccupied and unresolved/unclassifiable states of mind. As we discuss below, this hypothesis is consistent with a fine-grained analysis of the specific forms of discourse incoherence that correspond to different states of mind in the AAI. As a preliminary test, we tabulated all the studies we were able to locate in which intelligence scores were reported separately for the 4-way categories of attachment states of mind (Table 2). Three of these studies used the AAI while the remaining two used the AAP. We then calculated effect sizes (Cohen's d) for the difference between secure/autonomous and dismissing participants on the one hand, and preoccupied and unresolved/unclassifiable participants on the other hand. This approach circumvents the problem of very small Ns for certain categories in some of the studies (e.g., there were only four preoccupied participants in Crowell [1996], and only one secure participant in Rosenstein & Horowitz [1996]). The details of the effect size calculations are reported in the supplementary material.

As can be seen from Table 2, the data show a clear pattern of differences in the expected direction, with higher intelligence in secure and dismissing participants compared with those classified as preoccupied or unresolved. For studies employing the AAI, the mean difference in full-scale IQ was estimated at $d = 0.31$ (95 % CI [0.02, 0.59]; $k = 3$; $N = 195$). Across attachment measures, the corresponding difference was $d = 0.38$ (95 % CI [0.15, 0.61]; $k = 4$; $N = 296$). The mean difference in performance IQ across measures was $d = 0.31$ (95 % CI [0.05, 0.57]; $k = 3$; $N = 243$); whereas for verbal IQ the difference was smaller and non-significant: $d = 0.16$ (95 % CI [−0.20, 0.52]; $k = 4$; $N = 322$), due to the inclusion of the opposite-sign effect from Gander et al. (2017). Once again, publication bias can be safely discounted, as the comparisons in individual studies were almost all non-significant (and none of the studies tested the comparison we focused on in this analysis). Naturally, these results are preliminary, and as such they should be replicated and extended in larger datasets. However, they point to a clear and remarkable symmetry between children and adults, not just in the overall correlation between intelligence scores and security but also in the distribution of intelligence among specific attachment categories.

Psychometric issues

The same psychometric considerations that we made in the section on childhood can be repeated with respect to studies of adolescents and adults. In general, associations between intelligence and attachment states of mind are attenuated by limitations in test validity and reliability, and the latter is an especially salient concern in the measurement of attachment. However, adult classifications are somewhat more stable and reliable than their infancy and childhood counterparts (Pinquart et al., 2013). For example, inter-rater agreement for the AAI can be as high as $\kappa = 0.95$, while the short-term test–retest reliability is around $\kappa = 0.60$-0.80 for 3-way classifications and $\kappa = 0.40$ for 4-way classifications (Bakermans-Kranenburg & van IJzendoorn, 1993; Sagi et al., 1994; see Crowell, 2021). Moreover, compared with childhood studies, studies of adults more often employ full-scale IQ scores, which measure general intelligence with higher validity than individual scales or subtests. It is also noteworthy that coherence and security are scored dimensionally, and thus are characterized by higher levels of reliability than categorical attachment classifications.

Causal interpretation

In the passage quoted above, de Ruiter & van IJzendoorn (1993) noted that higher intelligence could help the construction of more flexible internal models, but might also increase the effectiveness of intellectual defenses based on the selective processing of information. We suggest that both these hypotheses are correct: while the former applies to secure/autonomous states of mind, the latter applies to dismissing ones. The defining features of dismissing AAI narratives—idealization, derogation, insistence on the inability to recall specific memories—do not point to low intelligence but to selective (if emotionally distorted) processing of information. In contrast, preoccupied interviews contain many potential indicators of reduced cognitive ability, such as nonsense words; vague, uninformative expressions; incomplete or grammatically entangled sentences; and narrative confusions between the self and the parent. Most of these phenomena are captured by the "passivity of discourse" scale (see Crowell, 2021). Unresolved states of mind are even more directly linked to lapses in reasoning and/or monitoring of discourse; and at least in some cases, the marked incoherence and hard-to-follow quality of unclassifiable interviews may reflect the participants' cognitive limitations in addition to their attachment insecurity (see Crowell, 2021; Hesse, 2016).

From the standpoint of intelligence research, it is natural to assume that individual differences in cognitive ability would be reflected in the quality of a person's discourse and conversational performance. Unfortunately, researchers in the field of communication pragmatics tend to disregard or downplay the concept of intelligence; in some cases, the euphemistic label of "formal language skills" is used to refer to what is essentially verbal intelligence (to the point that "formal language" is often measured with verbal subtests from IQ batteries; see Table B1 in Matthews et al., 2018). As in attachment research, the common use of small samples makes it difficult to consistently detect associations unless effect sizes are quite large. Despite these limitations, reviews of this literature have concluded that pragmatic abilities are moderately associated with both formal language skills (i.e., verbal intelligence) and performance on executive tasks, which is another reliable indicator of *g* (Matthews et al., 2018).

In total, we argue that intelligence can influence adult attachment classifications in two distinct yet related ways. First, intelligence contributes to people's ability to form stable, integrated representations of attachment relationships, especially when exposed to confusing and unpredictable interpersonal contexts. Second, it influences their ability to translate those representations into a coherent, comprehensible narrative form while simultaneously maintaining a cooperative conversation *sensu* Grice. These effects can be expected to amplify-one another in a synergistic manner: fragmented or inconsistent representations are harder to translate into a coherent narrative, making the conversational task disproportionately harder for people with lower levels of pragmatic abilities. As we discussed in the section on attachment in childhood, individual differences in intelligence do not *determine* attachment states of mind, but probabilistically "tip the scale" toward certain patterns of secure vs insecure discourse and corresponding narratives. The impact of intelligence on discourse coherence (especially when discussing complex interpersonal situations) likely contributes to explain why the AAI classification of psychotherapy clients can be predicted, with surprisingly high accuracy, from their conversation with the therapist during a session (coded with AAI-inspired criteria; Talia, Miller-Bottome, & Daniel, 2017; Talia, Miller-Bottome, Wyner, Lilliengren, & Bate, 2019b). This finding suggests the existence of generalized styles for communicating about one's relational experiences and internal states, which extend beyond the specific domain of attachment narratives. In our view, such generalized communication styles—which partly reflect the more or less integrated nature of the underlying representations—are not just the product of a person's attachment experiences, but are also influenced by stable individual differences in cognitive ability.

Intelligence and the intergenerational transmission of attachment

The mechanisms responsible for the transmission of attachment between generations are still surprisingly obscure. Ainsworth and colleagues (1978) showed that parental sensitivity—defined as the ability to perceive the child's signals and communications, interpret them accurately, and respond appropriately and promptly—is an important predictor of security (see Posada et al., 2021). However, the mediating effect of sensitivity only accounts for about half of the correlation between secure/autonomous states of mind in parents and secure attachment in their children (correcting for measurement unreliability; Verhage et al., 2016, 2018). Parental mentalization—the degree to which parents show frequent, coherent, or appropriate appreciation of their infants' mental states—correlates with both sensitivity and security, and has been proposed as an additional channel of intergenerational transmission (Zeegers et al., 2017); however, the effect is not large enough to close the "gap" between parent and child attachment. The transmission gap is especially wide in the case of the association between unresolved states of mind and disorganized attachment, which is mediated only in small part by the parent's anomalous behavior (Madigan et al., 2006). As summarized by van IJzendoorn & Bakermans-Kranenburg (2019):

> "After more than four decades of research and almost 100 attachment studies we still are in the dark about the mechanism of the transmission of attachment across generations" (p. 33).

The revised model we presented in Fig. 2 contains two causal pathways that contribute to explain the observed association between parents' state of mind and children's attachment.[6] From the standpoint of the mainstream assumption that this association reflects a causal effect of parental state of mind on child attachment, both pathways introduce confounding bias, leading researchers to overestimate the impact of attachment states of mind. The first pathway flows through parental and child intelligence (parent state of mind ← parent intelligence ↔ child intelligence → child attachment). The second pathway flows through sensitivity, mentalization, and related behavioral traits of the parent (parent state of mind ← parent intelligence → parent sensitivity and mentalization → child attachment).

Note that the first pathway should be specific to the associations between preoccupied and unresolved states of mind on the one hand, and ambivalent and disorganized attachment on the other hand; the second pathway connects preoccupied and unresolved states of mind with general insecurity, through the mediation of sensitivity and mentalization. While these associations contribute to the overall correlation between security in parents and children (i.e., the main focus of research on the transmission gap), it is important to remember that the patterns we describe imply a greater degree of specificity. Interestingly, the concordance between preoccupied or unresolved states of mind in parents and ambivalent or disorganized attachment in children is comparable to the concordance between parent and child security. Specifically, 51.9 % of preoccupied or unresolved parents have ambivalent or disorganized children, versus 25.4 % of secure or dismissing parents; for comparison, 69.2 % of secure parents have securely attached children, versus 36.7 % of insecure parents (4-way classification; data from Table 7 in Verhage et al., 2016).

[6] For an introduction to causal diagrams see Kline (2016); Pearl et al. (2016); Rohrer (2018).

First Pathway: Correlated intelligence in parents and children

Owing to the combined effects of shared genes and shared environments, the intelligence levels of parents and children show a robust positive association. The correlation between IQ scores (which are imperfect measures of *g*) in parent–child dyads grows from about 0.20 in infancy and early childhood to somewhat more than 0.40 in adolescence and young adulthood (Bouchard & McGue, 1981; Reed & Rich, 1982; Willoughby et al., 2021). As we noted earlier, the genetic component of intelligence becomes larger as children mature; this likely contributes to explain the increase in parent–child similarity on measures of cognitive ability over time. At the same time, correlations in infancy and early childhood are probably deflated by the lower validity of intelligence tests (e.g., the Bayley scales employed in most studies in this area).

The correlation between parent and child intelligence gives rise to an indirect causal pathway linking parent and child attachment, as shown in Fig. 2 (parent state of mind ← parent intelligence ↔ child intelligence → child attachment). This pathway should increase the intergenerational concordance between parents and children *without* the mediation of parents' caregiving behavior—thus inflating the apparent size of the transmission gap. In light of the persistent failure to fully account for the association between parent and child attachment, it is unlikely that future research will uncover a single, decisive factor that will solve the puzzle at once. More plausibly, the remaining half of the gap is the sum of several smaller, incremental effects such as the one we highlighted here.

Intriguingly, the same causal pathway may contribute to explain why the concordance between parent and child attachment tends to increase with children's age (Verhage et al., 2016), given that the "parent intelligence ↔ child intelligence" link becomes stronger over the same time frame (see above). Other research suggests that the heritability of attachment (especially measured with questionnaires) may become stronger from infancy to childhood (Barbaro et al., 2017); if confirmed, this pattern could partly reflect the increasing heritability of intelligence over the same time span.

Second Pathway: Effects of parent intelligence on sensitivity and mentalization

A great deal of research has explored the idea that sensitive, responsive parenting can increase children's cognitive ability (see e.g., Eshel et al., 2006). Most of the evidence is correlational, and hence unable to distinguish between alternative causal explanations of this association; but there are some randomized intervention studies that indicate a plausible causal effect of parental sensitivity on children's intelligence, especially in disadvantaged or at-risk conditions (e.g., Landry et al., 2006; Nordhov et al, 2010; see also Eshel et al., 2006; Pearson et al. 2011). At the same time, maternal intelligence is consistently associated with more supportive home environments, and parents with higher cognitive ability respond more sensitively during interactions with their infants (Pearson et al. 2011; Wertz et al., 2019). A recent longitudinal study using a complex sibling design found an interesting causal pattern: the mother's intelligence contributes to create a better home environment during early childhood, but by middle childhood and especially adolescence, the home environment increasingly becomes a function of the *child's* intelligence while the maternal effect fades out (Hadd & Rodgers, 2017). Adoption studies also show that the effects of parental behavior on child intelligence become very small by adolescence (Beaver et al., 2014).

Taken together, these data indicate that parental sensitivity can have a positive effect on children's cognitive development, either directly or by fostering attachment security; however, this effect is likely transitory and concentrated in infancy and early childhood, as indicated by the dotted arrows in Fig. 2. At the same time, the intelligence of parents does not just affect their attachment states of mind (see above) but also their sensitivity, which in turn contributes to determine children's attachment patterns. In total, this opens a causal pathway (parent state of mind ← parent intelligence → parent sensitivity → child attachment) that tends to reinforce the association between parental state of mind and child attachment, as well as that between parental state of mind and sensitivity. While this pathway flows through sensitivity and therefore cannot explain the transmission gap, the model suggests that the mediational effect of sensitivity (e.g., Verhage et al., 2016) has likely been overestimated, because the association between parental state of mind and sensitivity is partly confounded by the parent's intelligence (parent state of mind ← parent intelligence → parent sensitivity).

The same basic argument can be applied to the construct of mentalization, because the various components of mentalization (theory of mind, perspective taking, and so on) are also reliably correlated with IQ (e.g., Baker et al., 2014, Kurdek 1977, Rajkumar et al., 2008). Accordingly, scores on the AAI *reflective function* scale (a common indicator of mentalization) show a positive correlation with intelligence (Taubner et al., 2016). *Mind-mindedness* is another important construct that summarizes the parents' proclivity to attribute mental states to their infants and children (Meins, 1997). While we could not find any data on the association between mind-mindedness and parental IQ, several studies have found correlations in the 0.20-0.30 range with parental education and SES, which partly reflect individual differences in intelligence (see McMahon & Bernier, 2017). As noted by McMahon and Bernier (2017), about half of the correlations in the literature are non-significant, which is expected given the very small size of most samples. Moreover, a recent meta-analysis showed that parental mind-mindedness predicts children's cognitive skills (including general intelligence, language abilities, and executive functions) more consistently than it predicts behavioral outcomes such as internalizing/externalizing symptoms and negative affectivity (Aldrich et al., 2021). Collectively, this evidence suggests that mind-mindedness is likely to overlap with intelligence to some degree. In light of these considerations, Fig. 2 conceptually groups sensitivity and mentalization together as part of the same overall pathway (parent state of mind ← parent intelligence → parent sensitivity and mentalization → child attachment).

Conclusion

In light of the evidence and reasoning presented in this paper, we believe it is time to reconsider the role of intelligence in attachment theory. To this end, we have proposed a revised model that corrects some common but questionable assumptions in the field and suggests novel hypotheses for future inquiry. While we believe that our model is an improvement over the "standard model" that informs current attachment research, we also regard it as provisional—there remain many gaps and open questions that can only be answered with new data.

Before concluding, we briefly compare our model to another recent attempt to explain the connections between attachment and cognition, namely the epistemic trust hypothesis advanced by Talia and colleagues (2021). These authors set out to address some of the same issues we discussed in this paper—the pervasive but poorly understood associations between attachment and cognitive functioning, the finding that attachment states of mind in adults correspond to generalized communication and discourse styles, and the parent–child transmission gap. *Epistemic trust* is defined as the expectation that interpersonally communicated information is relevant to the addressee, and produced by a partner who considers the addressee's perspective (Fonagy & Allison, 2014; Talia et al., 2021). Talia and colleagues hypothesized that infant attachment patterns reflect differences in epistemic trust with respect to the caregiver (which in turn are caused by differences in the caregivers' communication styles); that these differences contribute to stable biases in interpreting and producing communication; and that the AAI and other measures of adult attachment capture a special case of these generalized epistemic biases.

The epistemic trust hypothesis is not incompatible with our revised model; in fact, we believe it would be productive to explore in some detail the associations between communicative styles, epistemic biases, and intelligence. From a causal standpoint, we think it plausible that individual differences in epistemic trust may arise, in part, as a function of parents' and children's levels of cognitive ability. In a sense, our model is more parsimonious as it relies on the well-validated construct of general intelligence; at the same time, the notion of epistemic trust may help enrich our own hypotheses about the causal links between intelligence and attachment, and identify additional mechanisms that may be developmentally and clinically meaningful.

The ability to integrate patterns of behavior, affect, and cognition within a single parsimonious framework has been a key strength of attachment theory since its inception (e.g., Bowlby, 1969/1982). For historical reasons, mainstream attachment research has become disconnected from the study of intelligence, but there is no reason why this state of affairs should continue into the future. Longitudinal datasets (including those compiled by consortia, e.g., the Consortium for Attachment Transmission Studies [CATS], Verhage et al., 2020) that include cognitive and/or educational indicators could be revisited with an eye toward testing competing models, for example using structural equation modeling techniques (SEM; Kline, 2016). The interface between attachment and intelligence is a fertile ground for investigation and discovery. By moving beyond correlations and starting to develop and test explicit causal models, researchers will be able to gain novel insights and contribute to answering long-standing questions about the dynamics of stability and change, the role of genetic factors, and the transmission of attachment between generations.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dr.2022.101054.

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