

## **The influence of dogs' presence on children's performance on cognitive tests: Implications for clinical practice.**

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Evidence suggests that cognitive assessments can evoke feelings of stress for some children, potentially inhibiting cognitive performance and undermining the validity of results. Dogs have been found to be an unobtrusive form of social support for children in other settings, potentially offering a solution to this problem. The aim of this paper was to critically review the literature to explore what effect, if any, dogs may have on children's performance on cognitive tests, and consider implications for clinical practice. To do so, five databases were systematically searched and returns were screened for eligibility. Studies were collectively described and then appraised using a common appraisal framework. Nine studies exploring the relationship between dogs and cognitive functioning in children ( $\leq 18$  years) were identified in the literature search. All used an experimental methodology and were of good to fair quality. Together, results indicated that the presence of a dog could reduce stress and enhance cognitive performance across various domains, lending experimental evidence to support the idea that dogs may support children undergoing cognitive assessments. Further trials are now required to explore the generalizability of these associations to clinical settings and implications for test validity. Further implications for policy and practice are discussed.

*Keywords:* Dogs, children, cognitive assessment, cognitive performance, clinical psychology

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### **Cognitive Assessments in Children's Mental Health Services**

In the UK, clinical psychologists working in child and adolescent mental health services (CAMHS) sometimes conduct cognitive assessments. These are used to profile examinees' strengths and weaknesses to provide tailored support specific to their needs (Lezak et al., 2012). For instance, results can inform Education, Health and Care Plans<sup>1</sup> (EHCPs), reasonable adjustments in education (see Equality and Human Rights Commission, 2015), and gatekeeping into specialist services.

Despite this rationale, for some children (defined here as people below 18 years of age), testing can be experienced as a stressful process. Testing commonly requires examinees to perform challenging tasks for a sustained period of time, often with an unfamiliar adult in an unfamiliar environment, which some children can find difficult - particularly those with pre-existing psychological difficulties and/or insecure attachment styles (Diamond, 2015), a group over-represented in clinical populations (Palitsky et al., 2013). Bayrak et al. (2018) found that insecurely attached individuals have reduced access to adaptive coping strategies when faced with a stressful situation, and thus greater vulnerability to stress. Children's awareness of the contingencies resting upon their performance could further influence feelings of stress (Howard, 2020).

An increase in stress levels has potential ramifications upon the validity of the assessment results. Cognitive assessments can only be helpful insofar as they provide an accurate representation of the examinee's abilities, yet substantial evidence relates test anxiety to reduced test performance for children (see von der Embse et al., 2018 for review). This may be related to the finding that anxiety impedes the functioning of the prefrontal cortex (Park & Moghaddam, 2017). Given the prefrontal cortex's role in "the maintenance of attention, the monitoring of information in working memory, and the coordination of goal-directed behaviors" (Teffer & Semendeferi, 2012, p. 192), few cognitive tests could be seen to evade this inhibitory effect. This casts question over the usefulness of test results when examinees experience test anxiety.

The finding that test anxiety can have an inhibitory effect on cognitive performance presents a dilemma for clinicians and service providers, because the standardised delivery format of the tests (see Lezak et al., 2012) means that emotional support is generally unavailable. For instance, clinicians are advised against permitting a parent or carer into the testing room with the child in case they were to be distracting or provide assistance. Likewise, most test protocols follow a scripted format that does not allow much feedback from the examiner that could put the examinee at ease (e.g. Wechsler & Kaplan, 2015).

It follows, therefore, that services might be improved by considering ways in which the testing *environment* could be altered to reduce stress or anxiety for children that experience testing in this way. Such improvements could improve the quality of care given to examinees, by increasing confidence in the validity of their assessment results, whilst also demonstrating the services' person-centred and compassionate values (National Health Service [NHS], 2018).

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<sup>1</sup> See <https://www.gov.uk/children-with-special-educational-needs/extra-SEN-help> for further information

## Dogs

In 2007, Deborah Wells summarised the multifarious ways in which dogs can positively influence humans' physical and mental health. More recent research supports and extends her claims: for instance, the finding that human-canine touch mutually increases oxytocin and dopamine, and decreases cortisol and blood pressure (Handlin et al., 2012; Pop et al., 2014).

Numerous papers have explored how dogs can improve children's experiences of the criminal justice system (e.g. Sandoval, 2010; Spruin et al., 2019); dentistry (e.g. Vincent et al., 2019); and physical health settings (e.g. Lindström Nilsson et al., 2019); as well as school reading performance (Hall et al., 2016). Similarly, Jones et al.'s (2019) review found that dogs positively impacted both engagement and outcomes in psychological therapy, supporting earlier claims that dogs can support children who find it difficult to engage in therapy (Levinson, 1962) or act out aggressive impulses (Eggiman, 2006). Further, several studies suggest that dogs improve the acceptability of psychological interventions (Jones et al., 2019), and service users rate and respond to therapists more positively in the presence of a dog (Isenstein, 2018; Schneider & Harley, 2006). Should this effect generalise to cognitive testing, this may serve to enhance engagement with the assessment process, the assessing psychologist, and the service alike.

Despite this proliferation of research, to date, it appears that little research has been conducted looking at the impact of dogs on children's test anxiety and its predicted impact on test performance – although Crossman et al. (2020) did find that interacting with a dog reduced anxiety among children more generally. In contrast, studies among adult populations suggest that dogs can reduce university students' biological stress markers prior to examination (McDonald et al., 2017), as well as self-reported wellbeing around the time of exams (Ward-Griffin et al., 2018). This may go some way to explain the finding that interacting with dogs prior to testing can positively influence outcomes for nursing students (e.g. Young, 2012): If dogs can indeed reduce test anxiety and/or stress (at least for some people), and anxiety impedes cognitive performance, it follows that some examinee's cognitive performance, and their experience thereof, could be enhanced by the presence of a dog - a naïve model through which the impact of dogs on children's test anxiety might be understood.

**Terminology.** As the field of animal-assisted interventions has developed, so too has the language used to describe the different ways in which dogs have been introduced to support humans, and Assistance Dogs International (2019) provide a helpful glossary of these key terms, which includes the following:

Therapy dog: a pet dog that is trained to provide affection, comfort, and love to those it interacts with in many different settings. Therapy dog owners may [...] visit with their animals to facilities in which the team is welcomed or may be practitioners who utilize the dog in a professional setting.

Facility dog: a specially trained dog that is working with a volunteer or professional who is trained by a program. The work of a facility dog can include visitations or professional therapy in one or more locations.

As both therapy and facility dogs might be relevant to supporting children undergoing cognitive assessments, the broader term of “dogs” or “canines” is used in this work.

## **This Review: Overview and Objectives**

There is evidence to suggest that the presence of a dog may positively affect the experience of cognitive testing for some children, potentially optimising validity whilst providing compassionate, effective care in line with NHS values. However, it seems equally possible that the converse could be true: dogs may prove distracting to examinees and/or examiners, and thus undermine the validity of the tests; and could likewise raise anxiety or distress in the case of examinees with fears or allergies relating to dogs (Terras, 2006). It is also possible that dogs' presence could benefit performance to a degree that lends advantage, compromising the established validity and reliability of tests, which are currently normed without dogs (Institute of Medicine, 2015). As such, the purpose of this review was to critically summarise the literature so as to explore the questions "what influence might a dogs' presence have on children's performance on cognitive tests" and "what implications might this have for clinical practice in the CAMHS context?".

## **Method**

### **Literature Search**

Five databases were searched (ASSIA, CINAHL, OpenDissertations, PsychINFO, and Web of Science) to capture psychological, medical, and social/community based literature, as well as unpublished dissertations. Searches were limited to "title only" to capture the most relevant literature. Due to the exploratory nature of this research all articles published before 24<sup>th</sup> May 2020 were searched, limited to English language papers.

The database search query used was: TI = ((child\* OR adolescen\* OR teenage\* OR "young person" OR "young people" OR student\* OR pupil\* OR pe?diatric\*) AND ("cognitive function\*" OR "cognitive test\*" OR "cognitive assessment\*" OR "psychometric test\*" OR "psychometric assessment\*" OR "neuropsychometric test\*" OR neuropsychometry OR "neuropsychometric assessment\*" OR "intelligence test\*" OR "intelligence assessment" OR memor\* OR "cognitive neuropsycholog\*" OR "executive function\*" OR "processing speed" OR "verbal fluency" OR perform\* OR concentrat\*) AND (dog OR canine OR "canine-assisted" OR "dog-assisted" OR "therapy dog" OR "assistance dog" OR "facility dog" OR "human-animal interaction" OR "animal-assisted"))).

To capture any missed literature, the reference lists of relevant articles were manually searched and ResearchGate was used to identify missed work by key authors. LinkedIn was used to request the full-text of a paper unavailable online, but unfortunately, no response was received. Three British university digital research archives (Canterbury Christ Church University, King's College London and the University of Edinburgh), a specialist human-animal research repository ("HABRI"), and Google were also searched using combinations of the above terms to capture any other missed or "grey" literature.

### **Selection and Review Process**

Database searching retrieved 50 articles, and manual searching contributed a further 12. Duplicates were removed before articles were screened for eligibility. For inclusion, articles had to be text-based and investigate dogs, children ( $\leq 18$  years) and cognitive performance; all other articles were excluded. Figure 1 summarises this process and outlines the number of papers identified at each stage of the search.

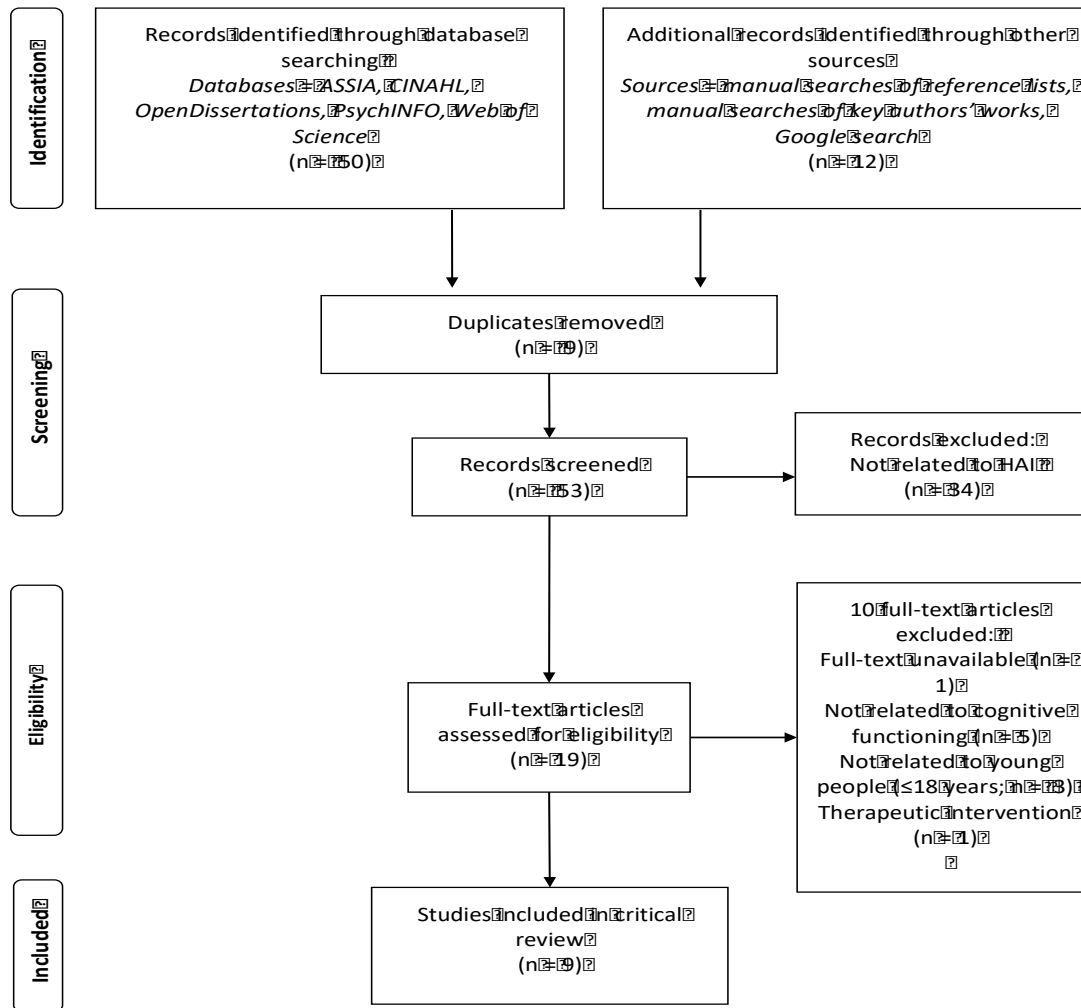


Figure 1: PRISMA flow diagram (Moher, Liberati, Tetzlaff, & Altman, 2009)

## Findings

### Approach

In total, nine studies were reviewed, all of which used quantitative methodologies. Due to the heterogeneity of the populations, experimental aims, and designs employed, meta-analysis was not possible. Studies were appraised for quality individually using the Specialist Unit for Review Evidence's (SURE, 2018) assessment framework for experimental studies to inform the degree of confidence attributable to the findings. Then, to provide a summary view of the literature, studies were collectively described and appraised. Study identifiers, key extracted data, and quality summaries are presented in Table 1.

## Study Description

**Studies Identified.** The nine studies were conducted in three laboratories: Two that sampled across both Austria and Germany, six in the USA, and one in Switzerland. All were published between 2007-2014 in three journals (Anthrozoös, Frontiers in Psychology, and the Human-Animal Interaction Bulletin).

**Aims.** All of the studies sought to assess the impact a real dog on some aspect of children's cognitive functioning as compared to one or more control groups. Studies covered all six of the cognitive domains specified in DSM-5's taxonomy (Sachdev et al., 2014; see Table 1), including attention (Studies 5, 8 & 9), executive functioning (Study 4), language (Studies 6 & 8), memory (Study 3, 4, 6, 7, 8, & 9), motor-perceptual skills (Study 7), and the HPA axis (stress-response pathway; Studies 1 & 2).

**Participants.** Participants' ages ranged from 3-14 years. Seven studies (Studies 3-9) included male and female participants, whereas two studies recruited only males (Studies 1 and 2). Children's cognitive ability varied across studies: Studies 1 and 2 recruited children who attended mainstream and special educational establishments with insecure-avoidant or disorganised attachment styles, Studies 3-8 recruited a mixture of developmentally delayed and typically developing preschool children from integrated classrooms (where developmentally delayed and typically developing children are educated in the same programme), and Study 9 only recruited typically developing children attending a mainstream school.

**Design and Setting.** All studies used an experimental design. Studies 1 and 2 used independent measures; Studies 3-8 used repeated measures; and Study 9 used a randomised controlled crossover design. Studies 1 and 2 used an unfamiliar classroom, Studies 3-8 used a laboratory setting near to the participants' school; and Study 9 did not report the setting. Room set-up was well described across studies.

**Intervention and Procedure.** Studies 1 and 2 allocated participants randomly to one of three experimental conditions: a real dog, a friendly human, or a toy dog. Participants were assessed using the Trier Social Stress Test for Children (TSST-C) and were free to interact with their allocated "social supporter" throughout the task. Salivary cortisol and self-reported mood was measured at five time points: before the test, after a period of time with the children's "social supporter", after the test, after debrief, and after a period of relaxation.

In Studies 3-8, children were randomised to different starting conditions, usually consisting of a real dog, a toy dog, and a human confederate. Children were assigned a task and asked to perform it in each condition in a randomised order, thus acting as their own controls. Studies 3-6 included picture sorting, matching, or recall. Studies 7 and 8 involved an obstacle course, in which the participant copied, mirrored or raced their "co-performer" (dog, toy or confederate).

In Study 9, participants were randomly allocated to either a real dog or robot dog condition. Participants interacted with their "dog" for 15 minutes prior to performing a series of cognitive tasks including a digit span task, a cancellation screen, a continuous performance test and a divided attention test. The "dog" lay by their feet during testing. Each participant completed the tasks in both conditions, acting as their own control. Passive infrared hemoencephalography (PIR HEG) was used as a biological correlate of attention during these tests.

Table 1  
*Study Characteristics and Subjective Quality Assessment*

No	Authors (Date), Country/ Countries	Experimental design	Domain(s)*/ neurocognitive pathway assessed	Sample (Gender, age range)	Key Findings Related to Presence of Dog During Testing	Quality **
1	Beetz, Julius, Turner & Kotrschal (2012), Germany & Austria	Independent measures	HPA axis	M=47, 7-11yrs	Significantly associated with reduced cortisol levels	Good
2	Beetz, Kotrschal, Turner, Hediger, Uvnas-Mober & Julius (2011), Germany & Austria	Independent measures	HPA axis	M=31, 7-12yrs	Significantly associated with reduced cortisol levels	Good
3	Gee, Belcher, Grabski, DeJesus & Riley (2012), USA	Repeated measures	Memory	M=11, F=9, 3-5yrs	Significantly associated with increased speed and accuracy	Good
4	Gee, Church & Altobelli (2010), USA	Repeated measures	Executive function & memory	M=7, F=5, 3-5yrs	Significantly associated with improved task performance	Fair
5	Gee, Crist & Carr (2010), USA	Repeated measures	Attention	M=6, F=6, 3-5yrs	Significantly associated with improved task performance	Good
6	Gee, Gould, Johnson & Wagner (2012), USA	Repeated measures	Memory & language	F=10, M=7, 3-5yrs	Significantly associated with improved task performance	Good
7	Gee, Harris & Johnson (2007), USA	Repeated measures	Memory & perceptual-motor function	F=4, M=10, 4-6yrs	Significantly associated with improved task performance	Fair
8	Gee, Sherlock, Bennett & Harriss (2009), USA	Repeated measures	Memory, attention & language	F=3, M=8, 3-5yrs	Significantly associated with increased speed	Fair
9	Hediger & Turner (2014), Switzerland	Randomised controlled crossover trial	Memory & attention	M=13, F=11, 10-14yrs	Non-significant improvement on some tasks; significant learning effect on some tasks	Good

\* Follows the six-domain taxonomy specified in DSM-5 (Sachdev et al., 2014)

\*\* Study quality was appraised using the SURE (2018) framework; full notation available by request

**Outcomes and Authors' Conclusions.** In Studies 1 and 2 it was reported that participants in the real dog condition spent significantly more time interacting with their "social supporter" prior to the test, and significantly less time interacting during the test, than those allocated to the toy dog condition. Only participants in the real dog condition had significantly lower salivary cortisol levels after the test. Time spent stroking the real dog, but not the toy dog, before the test was positively associated with drop in cortisol level. Changes in self-reported mood were not significant. The authors concluded that physical contact with a dog was the most effective form of social support for participants, and that it did not distract children during testing.

Studies 3-8 found a main effect for participants in the dog condition for all tasks. For matching and sorting tasks (Studies 3-6), children in the dog condition were significantly faster and more accurate. An anecdotal finding was that "the children didn't have to like [...] the dog to benefit from his presence" (Gee et al., 2012, p. 299). For the motor tasks (Studies 7 & 8), it was found that participants' adherence to instructions for modelled tasks was significantly better in the dog condition, but no significant differences were found in the mirroring or race conditions. Tasks were completed more quickly in the dog condition, without compromising accuracy. The authors conclude that the dog aided cognitive performance and was not a distraction.

The authors of Study 9 reported a non-significant trend towards improvement in the real dog condition on the digit span and cancellation screen tests, but no clear difference in the continuous performance or divided attention tests. In the digit span and divided attention tests the presence of the dog was associated with significantly improved test scores in the second test condition. The authors suggest that the presence of the dog improved the participants' ability to learn how to perform these tests, perhaps via increased attention and/or concentration. PIR HEG data indicated that attention was reduced in the robot dog, but not the real dog, conditions, and concluded that real dogs are not a distraction but robotic dogs can be.

### Study Appraisal

**Study Focus.** All of the studies addressed a clearly focused hypothesis exploring the impact of the presence of a real dog on a specified aspect of children's cognitive performance as compared to one or more control groups. They all used a clearly defined population, and all but Study 1 reported the setting and room set-up, contributing to good replicability. However, only Study 9 reported a clear exclusion criterion.

**Design.** All studies were small-scale exploratory experiments. Most were well controlled, accounting for potential sources of bias and confounding variables – such as room temperature where the PIR HEG was used (Study 9). However, no studies separated proximity to the dog from interaction with it and in Study 5 the dog's role varied among tasks. As such, providers seeking to integrate dogs into assessments may be unclear as to how to effectively achieve this aim.

All but Study 7 used a human confederate as a control group; six also used a toy dog condition (2, 3, 4, 5, & 8) and Study 9 used a robot dog. In most studies (3, 4, 5, 6, 7, 8 & 9) participants acted as their own controls. Studies 1 and 2 randomly allocated children to different groups, though the process of randomisation was not described. Indeed, only Studies 3 and 6 described the process of randomization, which appropriately used a random number generator, lending confidence to these findings.



Studies 1-6 and 8-9 used active control groups, and only Study 7 used an inactive control. Active control groups are encouraged when testing a novel intervention against an established intervention (see Karlsson & Bergmark, 2015), but toys, robots and human social supporters do not have a well-established effect in the cognitive testing literature. As such, this omission means that it is not possible to see whether examinees could also derive significant benefit from these alternative, and perhaps more pragmatic, interventions.

**Intervention.** In general, interventions and comparisons were well described and appropriate to the study aims. Aside from the intervention, groups were treated equally. Study procedures and protocols were standardised in all studies. Studies were generally very well described and therefore highly replicable. Sufficient effort was made to avoid order effects where a within-subjects design was used. The demographics of dog(s) handlers' and/or human confederates' (where used) was often inadequately attended to, however. Some studies did report age range (Studies 1, 2, 4, & 5), gender (Studies 1-6), familiarity with the participants (Studies 3, 4, 5, 6, & 8), demeanour (Studies 1 & 2), and/or responsibility for safety (Study 9). Five studies also provided information about the experimenter, generally limited to gender (Studies 1, 2, 3, 5 & 6). As experimenter demographics have been linked to findings in studies of children's cognitive performance, differences could affect both outcomes and replicability (e.g. Chapman et al., 2018).

In contrast, good consideration was given to dog characteristics. All but Study 2 reported the number of dogs that participated in the study, their breed(s), and their certification status. Study 2 reported only certification status. Evidence suggests that dog breed explains some of the variability in human-canine bonding and communication (Konno et al., 2016) and is thus an important control variable.

**Ethics.** Just five studies (1, 2, 3, 6, & 9) reported that they received formal ethical approval from a committee. This is concerning, particularly given the vulnerability of the participants, the task demands, and the inherent risks of human-animal interaction. SPSS Statistics (version 23.0) was used to analyse these figures, revealing that year of publication and reporting of ethics was positively correlated ( $r_s = .885$ ,  $p = .002$ ), indicating increased rigour in contemporary publishing standards.

Likewise, only Study 9, the most recent of the studies, received ethical approval from an animal ethics committee. Of the remaining studies, five described how ethical concerns were managed (Studies 3, 5, 6, 7, & 8), three of which in detail sufficient to satisfy the guidelines specified in the International Association of Human-Animal Interaction Organizations' (IAHAIO's) Prague Declaration (1998; Studies 3, 6 & 8). Glenk (2017) reviewed the impact of canine-assisted interventions on dog welfare and found that dogs frequently experience stress in work of this kind. For these reasons, the lack of consideration of animal ethics is also concerning.

**Sample.** Studies 1-8 recruited children of mixed neurocognitive status, with some participants being developmentally delayed, and others typically developing. Children with special educational needs are more likely to experience difficulties when performing cognitive tasks, and evidence suggests that they are also more likely to experience mental health difficulties (Rose et al., 2009), which could be reflected by higher sensitivity to stress. Studies were adequately powered to run main comparisons but had insufficient power to detect within group differences such as developmental status. A larger sample size was needed to know what impact this had, particularly as anecdotal evidence from studies supported the idea that developmentally delayed children derived more benefit from

the dogs than the typically developing children did – a notion supported by the weaker associations found in Study 9, which used a mainstream school sample.

Aside from this, participants appeared to be similar at baseline with regards to key characteristics, such as age and attitudes towards dogs. However, only Studies 4 and 7 reported demographic data such as cultural heritage, which could, plausibly, influence attitudes to dogs (Turner, 2010). Indeed, the authors of Study 3 state that some participants responded differently to the dog than others, yet as heritage and faith background were not reported it is not possible to know whether these variables could account for this. Greater focus on participant demographics could have been informative and, with larger samples, may have enabled meaningful comparisons.

In short, the heterogeneity of participant characteristics can be considered a limitation given the small sample size of these studies. Lack of statistical power precluded between-group comparisons, making the detection of demographic effects difficult. Where this was attempted (Study 6) results were not significant. Presenting results case-by-case, rather than averaging across heterogeneous populations, may have cast light upon differences attributable to uncontrolled variables such as such as attitudes towards dogs or cognitive ability. Nonetheless, the large effect sizes found in several studies, despite this small sample size, indicates compelling evidence for a meaningful real-world effect (Cohen, 1988).

**Measures.** All studies used psychometric or behavioural outputs. Study 9 used four well-validated measures from established assessment batteries, including subtests from the Wechsler Intelligence Scale for Children (WISC; Wechsler & Kaplan, 2015) and the Candit (2001) battery. Five studies used bespoke rating scales (Studies 1, 2, 5, 8, & 9). Measures were well described in the text, but only two reported inter-rater reliability (Studies 5 & 8) and only Study 2 offered internal consistency scores for psychometric measures, without which it is difficult to discern whether the phenomenon under study was reliably captured. In Studies 1 and 2, self-report tools comprised the Self-Assessment Manikin (SAM; Bradley & Lang, 1994) and Visual Analogue Scales (VAS; Bond & Lader, 1974), both of which have a precedent in the child literature. However, as the authors acknowledged, the SAM uses a single item to assess each mood state and may lack sensitivity, perhaps explaining the null results.

Two studies also used physiological measures: salivary cortisol and PIR HEG. Salivary cortisol has long been used in research exploring stress responses and the methodology is documented to be valid and reliable (Kirschbaum & Hellhammer, 1994). The process by which cortisol samples were obtained, stored, and analysed was reported in sufficient depth. In contrast, PIR HEG is an emergent technology. It does have a clinical precedent which has further developed since the reviewed study was published (e.g. Serra-Sala et al., 2016), and its mechanism of action is described by Shoshev (2017). However, few randomised controlled trials have been published and thus it requires further validation, thus results should be interpreted cautiously.

**Data Analysis.** For all studies, the experimental designs used precluded the use of participant and investigator blinding, making data blinding important. However, no studies reported that this took place, potentially introducing bias into the analysis, such as expectancy effects. Similarly, no studies reported a pre-specified statistical analysis plan, which may also have introduced bias into the analysis, potentially leading to multiple *post-hoc* comparisons that could jeopardise statistical validity.

Nonetheless, in general, studies were well analysed and results were clearly reported. Statistical methods used were adequately described and appropriate; with all studies reporting effect sizes, although no studies reported confidence intervals. Primary outcomes were clear in all studies and it appeared that all of the important outcomes were assessed; sources of bias were well accounted for and author conclusions were adequately supported by the data.

### **Critical Synthesis**

By synthesising the findings from the reviewed studies it becomes possible to understand not only *if* dogs influence cognitive functioning in children, but also *how*. This information, when integrated into the naïve model, whereby interacting with a dog reduces stress, thereby improving cognitive performance, provides a model with far greater explanatory power (Figure 2). This model can be tested and refined in future research to further understand the factors influencing the relationship between dogs and children's cognitive functioning.

Consistent with predictions from the naïve model, Gee and colleagues' series of studies (3-8) indicate that when a dog is available during a demanding task, cognitive performance is enhanced across domains. These findings held when clinical assessment tools were used in Hediger and Turner's (2014) study of memory and attention. Taken together, these studies indicate that dogs improve examinees' ability to attend to the task at hand, which subsequently improves cognitive performance.

Initially this finding might be perplexing: given the high salience of a dog's presence one might predict that children would be more interested in the dog than the task at hand. However, attachment theory, as explored in Beetz and colleagues' (2011, 2012) studies, offers an explanation. This theory predicts that in stressful situations children seek comfort from a social supporter (Bowlby, 1982). Beetz and colleagues (2011, 2012) found that salivary cortisol was inversely related to the time participants spent physically interacting with dogs, and thus argue that dogs provide a form of social support.

Thought to be the "fight-or-flight" hormone, cortisol is commonly believed to prime mammals to attend to threat and to seek safety (Montoya et al., 2015). Attention towards higher-order cognitive tasks that do not serve this purpose, as are typically measured by cognitive assessments, would therefore be limited. This is consistent with findings that "[e]ven quite mild acute uncontrollable stress can cause a rapid and dramatic loss of prefrontal cognitive abilities" (Arnsten, 2009, p. 410). As such, it appears that physical interaction with dogs modulates children's cortisol response to stressful situations, and in so doing, modulates cognitive performance.

### **Discussion**

#### **Findings**

Nine experimental studies were reviewed, providing tentative evidence that dogs can improve children's performance across a range of cognitive domains, including attention, executive functioning, memory, language, and perceptual-motor function, as well as influencing the stress-response pathway. None of the studies found the presence of a dog to be detrimental to children's performance, and several reported that the dog's presence was acceptable to the children. Taken together, this supports the notion that, for some, dogs could offer an effective means by which to improve the cognitive testing experience.

Some confidence can be placed in these results as all studies were of good to fair quality, and methodologically weaker studies yielded findings consistent with the stronger studies. Consistency in findings despite the diversity of interventions, measures and methods of analysis used adds further confidence to these conclusions (Patton, 1999). Systemic bias cannot be discounted, given the small pool of laboratories and journals; however, the findings are also concordant with the adult literature. For instance, in one study, Trammel (2017) found that interacting with a therapy dog prior to sitting an examination significantly reduced university students' self-reported stress levels and significantly improved their exam performance.

### **Critiquing the Model**

The emergent model (Figure 2) uses attachment theory and findings from experimental psychology that high levels of cortisol impede cognitive functioning to explain the amalgamated findings of the studies. Compellingly, the model accords with broader literature that support the idea that dogs can be attachment figures for humans (Kurdek, 2008); that stress activates attachment-seeking behaviour, and attachment figures reduce stress via proximity and pleasant touch (Bowlby, 1982); and that pleasant touch releases mood-boosting hormones such as oxytocin (Morrison, 2016). Beetz and colleagues' findings that only the real dog condition (compared with the toy dog and unfamiliar human conditions) significantly influenced cortisol levels supports the primacy of attachment in this process beyond pleasant touch alone (Beetz et al., 2011, 2012).

Amalgamating the results in this way may be an incomplete explanation of the way in which dogs influence cognitive performance, however. For instance, whereas touch is indicated as a means to activate the attachment system under an attachment-based model, evidence from the broader human-animal interaction literature base indicates that proximity may suffice. This finding has real-world implications for the clinical setting. Emergent evidence suggests that dogs' and humans' heart-rate variability synchronises over short distances (Horton, 2016), an effect well-documented in the equine-assisted therapy literature (e.g. Lanata et al., 2016). Evolutionary anthropologists argue that humans and dogs have hunted together for many thousands of years (Schleidt & Shalter, 2003), and intuitively the mutual detection of stress signals would augment this process. However, Grossberg and colleagues (1988) found no effect of proximity to a dog on heart rate or blood pressure during a stressful arithmetic task, and Beetz and colleagues (2011, 2012) found positive associations between time spent touching the dog and salivary cortisol levels, casting doubt upon this theory. Nevertheless, as none of the nine studies formally separated touch from proximity this hypothesis cannot be discounted.

Another explanation meriting further consideration is that interacting with a dog improves mood, which improves performance via a positive feedback loops, based upon the theory of self-fulfilling prophecy (Merton, 1948), wherein mood enhances self-belief, and self-belief modulates performance. This helps to explain Hediger and Turner's (2014) finding that the robot dog also somewhat improved cognitive performance, and is supported by evidence from Odendaal and Meintjes (2003) that interacting with a dog was associated with increased dopamine. However, six of the reviewed studies used toy dogs as controls with very limited effects on task performance, and one study recruiting very young children reported that the toy dog appeared distracting to participants, casting doubt upon the theory of self-fulfilling prophecy as the primary effector of change.

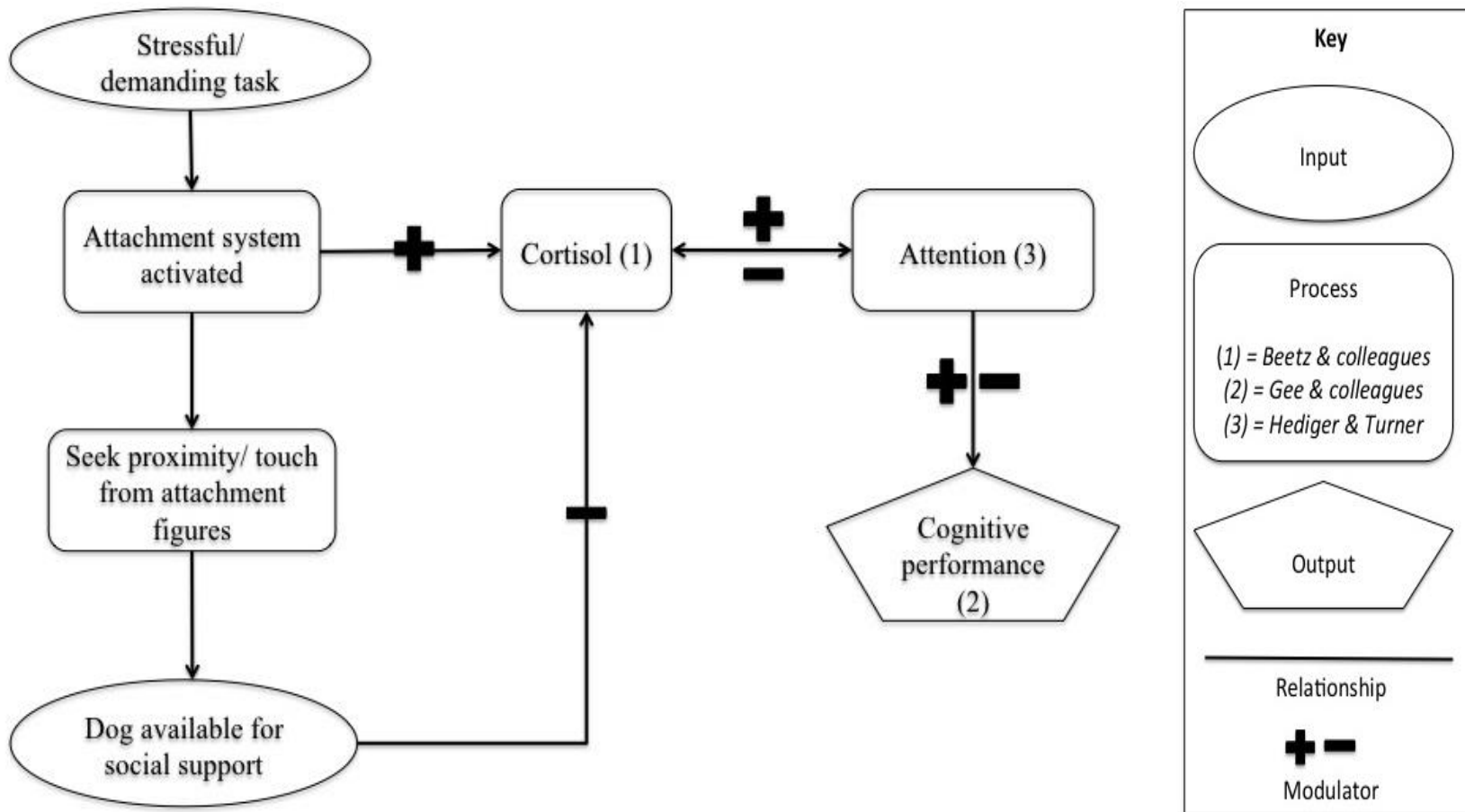


Figure 2. Emergent model from critical synthesis detailing possible impact of dog on cognitive assessment

### **Relevance to a Clinical Context**

The reviewed papers provide some preliminary but encouraging evidence to support the use of dogs to help anxious children while taking cognitive assessments. However, as none of the studies were conducted in true-to-life clinical settings, with common cognitive tests used with a clinical population, generalizability to the CAMHS environment can only be cautiously inferred. Nonetheless, several features of the studies can be seen to strengthen the likelihood of their generalizability.

Firstly, although none of the studies included clinical populations, Studies 1 and 2 explicitly recruited participants with insecure attachment styles, which may plausibly represent a proportion of CAMHS service users. The majority of the studies also included language or developmentally delayed children (Studies 1-8), who are more likely to be cognitively assessed in CAMHS than neurotypical children. Study 9 used typically developing school children without identified distress or behavioural difficulties, therefore Hediger and Turner's (2014) findings are the least generalizable to the CAMHS setting in this regard – though, noticeably, this study also found the least compelling evidence for the benefit of a dog.

Secondly, although only Study 9 included formal cognitive assessment tasks used in CAMHS, some generalizability can be inferred from the remaining studies by considering overlaps between the task demands in each setting. For instance, Studies 1 and 2 used mathematical tasks that could be seen as invoking similar demands as the arithmetic sub-test on the WISC. Similarly, the motor skills recruited in Studies 4 and 5 would, arguably, be essential for tasks such as the Block Design component of the WISC, sorting tests (e.g. the Tower of Toronto, the Peg Moving Task), and many processing speed tests (e.g. Trail Making, Cancellation, or Symbol Search). Likewise, the object and picture recognition tasks used in Study 5 bear close resemblance to several standardised memory tests such as the Facial Recognition Test (see Lezak et al., 2012, for test details).

More generally, one could argue that the tasks of attending to, retaining, and acting upon spoken instructions, as assessed by Studies 3, 5 and 8, are a fundamental part of most, if not all, cognitive testing experiences. In studies assessing adherence to task instructions, the fewest prompts were necessary for children in the dog condition, and most for children in the human confederate condition. This has practical importance for the CAMHS testing environment in which an examiner would usually give children verbal instructions. A “no intervention” control group would have been a useful addition to Studies 1-6, 8 and 9, allowing more direct comparison with standard practice in the CAMHS setting.

### **Implications for Future Research**

These results provide impetus for further research, particularly to assess how applicable the findings may be to the CAMHS cognitive testing environment. Future studies could aim to replicate the reviewed studies with larger samples, clinical populations, a broader age range, and standardised assessment batteries. The use of a “treatment as usual” condition alongside active control groups would make a helpful comparator given that this is an emergent evidence base. If stress-reducing effects can also be found from toys or robots these may offer more pragmatic solutions for services (see O'Cathain et al., 2015), though as some studies noted these to be distracting to children this would require further exploration.

Importantly, experience-close, qualitative accounts would help to understand the perceived impact of dogs on testing from service-users' perspectives. Likewise, it could be

important to exploring the potentially competing needs of the children accessing the CAMHS environment, some of whom may find comfort in dogs, and others of whom may find them off-putting, potentially discouraging attendance. Other matters, such as allergies and the dog's welfare, may also need to be explored (Hodgson et al., 2015).

These results also have ramifications for test validity. If dogs can improve cognitive performance, this could, potentially, move the overall distribution of scores and invalidate established norms. Re-validating tests to accommodate dogs (or other interventions) for some children but not others could be a lengthy and complicated process, deserving focused attention should this area develop further. Mediation analyses (Baron & Kenny, 1986) may help establish to what extent improvement in the presence of a dog is a function of anxiety, indicating which children might benefit from a dog, and lending a possible starting point for this enterprise.

### **Implications for Policy and Practice**

Although further research is merited, these results provide preliminary support for the idea that dogs could help to improve the cognitive testing experience for some children, potentially providing a buffer against the test anxiety that cognitive assessments can sometimes induce, which may, in turn, influence the validity of examinees' results. This holds important implications for clinical practice and policy development; wherein there is an ethical mandate to provide safe, effective, good quality care that *at the very least* does no harm (NHS, 2018). Service providers might, therefore, begin preliminary explorations as to how these ideas can be applied in clinical settings. For instance, small-scale service development projects could be designed to survey attitudes and preferences among service users and professionals. Service providers could consider piloting dog-assisted cognitive assessments in low-stakes situations to explore the clinical impact of the initiative, and to explore the feasibility of the intervention from an organisational perspective. Such studies might also illuminate pragmatic challenges to the implementation of these interventions in the NHS system that would require thought before larger-scale projects and policy changes can be instigated. It is of note that contemporary child-centred justice approaches lend a precedent to this work (see e.g. Spruin et al., 2020) and may offer a helpful starting point for mental health and allied services' development.

### **Limitations of this Review**

This main limitation of this review is the small number of studies that met the inclusion criteria, which were conducted in just three laboratories and have heterogeneous samples. Caution should therefore be applied when interpreting the results and applying these to clinical settings. Broadening the search to include papers written in languages other than English might retrieve a greater number of studies eligible for inclusion in future reviews. In addition, whilst taking a critical stance, this review did not include two researchers to appraise the studies, which may have biased the balance given to the results (see May et al., 2016). Additionally, due to time limits, it was not possible to contact authors working in the field directly to retrieve unpublished work, thus the positive findings reported here may represent the "file drawer" effect, wherein null results go unpublished. Nonetheless, the abstract of one unpublished Doctoral dissertation (Becker, 2014) likewise found positive effects of dogs on children's cognitive performance. These limitations notwithstanding, as the first study of its kind, this review may serve to propel further research from which stronger conclusions may be drawn.

## Conclusion

Nine studies were critically reviewed. Studies were heterogeneous in design, but consistent in their results and of good to fair quality, offering limited but meaningful evidence to support the use of dogs in cognitive assessments. An attachment-based model was developed to explain these findings, and future research is required to test and refine this model. Such research would benefit from larger samples derived from clinical populations and using standardised cognitive tests to show how these results generalise to the clinical setting. Ambitious and progressive services could consider piloting the inclusion of dogs in assessments to meet the ethical mandate for compassionate care whilst furthering the empirical cause.

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