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ARTICLE

The self-reference effect in attention deficit hyperactivity disorder

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Abstract
The self-memory system depends on the prioritization and capture of self-relevant information, so may be disrupted by difficulties in attending to, encoding and retrieving self-relevant information. The current study compares memory for self-referenced and other-referenced items in children with ADHD and typically developing comparison groups matched for verbal and chronological age. Children aged 5–14 ($N=90$) were presented with everyday objects alongside an own-face image (self-reference trials) or an unknown child's image (other-referenced trials). They were asked whether the child shown would like the object, before completing a surprise source memory test. In a second task, children performed, and watched another person perform, a series of actions before their memory for the actions was tested. A significant self-reference effect (SRE) was found in the typically developing children (i.e. both verbal and chronological age-matched comparison groups) for the first task, with significantly better memory for self-referenced than other-referenced objects. However, children with ADHD showed no SRE, suggesting a compromised ability to bind information with the cognitive self-concept. In the second task, all groups showed superior memory for actions carried out by the self, suggesting a preserved enactment effect in ADHD. Implications and applications for the self-memory system in ADHD are discussed.

KEYWORDS
attention, attention deficit hyperactivity disorder, enactment effect, memory, self, self-reference effect

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Statement of contribution

What is already known on this subject?

- Memory encoded with reference to self incurs a memory advantage (the self-reference effect; SRE).
- The SRE has been linked to attentional biases.
- It's unclear whether children with ADHD show the same level of SRE as other children.

What the present study adds?

- Children with ADHD did not show an SRE, while chronological and verbal age-matched children did.
- The SRE may be reduced in ADHD due to the attention required to bind self-referenced information.

BACKGROUND

Self-cues reliably capture and sustain attention (Humphreys & Sui, 2016), and organize and elaborate incoming information within the self-concept (Klein & Loftus, 1988). This ensures self-referenced information is better remembered than information encoded in other contexts, a pattern known as the self-reference effect (SRE) in memory (Rogers et al., 1977; Symons & Johnson, 1997). The SRE is well-established in adults (Klein et al., 2011), and neatly illustrates the long-recognized entwinement of self and memory (Hume, 1739/2003; James, 1890; Locke, 1690/1995). This link is described in Conway's influential self-memory system (SMS; Conway, 2005; Conway & Pleydell-Pearce, 2000), in which it is argued that self-concept (i.e. store of autobiographical memories and semantic self-knowledge) motivates attention and memory to capture further self-referent information, creating a bidirectional SMS. However, our understanding of the development of the SMS is limited (Ross et al., 2020). The current study aims to address this knowledge gap by using the self-reference paradigm as a tool to explore how mnemonic self-processing develops and, importantly, diverges in childhood. Specifically, we seek to elucidate the potential divergence of the SMS in a developmental disorder associated with difficulties in attention and memory: attention deficit hyperactivity disorder (ADHD).

ADHD is common and characterized by neurodevelopmental difficulties. Five per cent of children are reported to be functionally impaired by symptoms of persistent patterns of inattention and distractibility, hyperactivity and impulsivity (Polanczyk et al., 2007; Russell et al., 2014). People with ADHD tend to show difficulties in numerous aspects of executive functioning in comparison to typically developing (TYD) groups (Barkley, 1997; Boonstra et al., 2005; Raiker et al., 2012; Rhodes et al., 2004, 2005, 2012), including differences in inhibitory control, working memory and decision-making (Coghill et al., 2018). They also show difficulties in other cognitive functions, including difficulties in basic memory processes such as holding information in memory over a short delay and in long-term recognition and recall (Rhodes et al., 2004, 2005, 2012). However, there is little discussion in the literature concerning the cognitive representation of self in ADHD (Klein et al., 2011). This is notable since Conway's SMS suggests that we depend on attention and memory to maintain a coherent sense of identity. It follows that disruptions in attention and memory, as found in ADHD, may compromise the development of the self-concept and its impact on cognition.

In support of this reasoning, the typical development of executive function is positively associated with the development of autobiographical life narratives (Nieto et al., 2018). Binding episodic information to contextual details, such as self-relevance, requires attentional resources at encoding (Mangels

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et al., 2001), and accordingly, ADHD is associated with difficulties in episodic and autobiographical recollection (Alderson et al., 2014; Fabio & Caprì, 2015; Fuermaier et al., 2013; Rhodes et al., 2005). This implies that the autobiographical self-knowledge base described in Conway's SMS theory may be disrupted in ADHD.

To date, only one study has applied the SRE paradigm to elucidate the nature of self-specific memory processing in ADHD (Klein et al., 2011). This study presented both TYD adults and those with ADHD with trait words in a self-referent (i.e. *Does the word describe you?*), structural (i.e. *Is the word written in capital letters?*) or semantic (i.e. *Does the word mean the same as XXX?*) context. They found a similar SRE in the TYD and ADHD groups, suggesting both were able to utilize the additional elaboration and organization of the self-concept to support memory for self-referenced items (Klein & Loftus, 1988). However, in a second experiment, Klein et al. contrasted structural and semantic encoding with an autobiographical self-referencing task (i.e. *Recall an experience in which you showed this trait*). Under these conditions, the participants with ADHD underperformed relative to those in the TYP group, and showed a significantly weaker SRE. These findings suggest that people with ADHD may benefit from knowledge-based self-referential encoding (drawing from stored semantic memory), but not autobiographical encoding.

While interesting, Klein et al.'s (2011) results are difficult to interpret from a developmental perspective, since participants were all academically able university students, which is not typical of the ADHD population (Loe & Feldman, 2007; Zentall, 1993). The disruptive symptoms of ADHD typically lessen in adulthood, and more representative samples might be gathered in childhood (Faraone et al., 2006). Traditional SRE paradigms, while too linguistically challenging to apply early in development, have been adapted for children (Cunningham et al., 2014; Ross et al., 2011). For example, Ross et al. (2020) applied age-appropriate SRE tasks to establish that 3- to 6-year-old children's autobiographical memory is predicted by their ability to bind information to the self-concept, and is both predicted by and predictive of self-knowledge. This provides clear confirmation of a bidirectional SMS in TYD children. However, to date, we have no information on how the SMS may diverge in children with ADHD. The first step in this research line is to establish whether children with ADHD show self-reference effects. This was the primary aim of the current study.

We tested children with ADHD on a standard SRE task, thought to depend on attention and the ability to bind information to the self-concept (Cunningham et al., 2014). As a comparison, we also tested children's ability to recall their agentive role in physically experienced events, using an enactment effect paradigm (Cohen, 1989). This task requires children to observe or perform actions, and tends to elicit a superior recall of self-performed actions relative to those observed (Ross et al., 2011, 2020). Rather than involving effortful attention to and binding of information with the self-concept, the enactment effect is thought to arise naturally from the superior depth of processing arising from planning and embodying an action (Engelkamp et al., 1994). This distinction is important since we might expect the ability to benefit from enactment to be robust to developmental difficulties in the cognitive organization of self-knowledge. Accordingly, we tested children's performance on the standard SRE task (in one of two difficulty levels) and enactment task across three experimental groups: those diagnosed with ADHD, a comparison group matched to the ADHD group on verbal age and a comparison group matched on chronological age. All data from the study are available for open access at [blind review link: https://osf.io/3p4zf/?view_only=b8f4e9e1c8b7452bb8f44b0a1979e7a5].

METHOD

Participants

Ninety children aged 5–14 years (50 female, 40 male) took part in the study, comprising 30 children diagnosed with ADHD, 30 children matched with the ADHD group on chronological age (CA group) and 30 children matched with the ADHD group on verbal age (VA group; see Table 1 for group characteristics). Participants included in the matched groups were selected from a larger sample of typically

TABLE 1 Sample characteristics by group.

	N	Gender ratio (M:F)	Age range	Mean (SD) chronological age	Mean (SD) verbal age
ADHD group	30	12:18	5–14 years	123.8 (28.3) months	84.2 (14.6) months
Chronological age-matched (CA) group	30	13:17	5–14 years	119.7 (23.9) months	108.1 (22.9) months
Verbal age-matched (VA) group	30	15:15	5–11 years	107.1 (19.6) months	86.9 (14.2) months

developing children recruited for a separate project (no participants were included in the final sample of both projects). The selection of children for inclusion in the sample was done on the basis of their CA and VA scores by a researcher blind to task performance; if more than one match was available, then the relevant participant tested first chronologically was selected for inclusion in the current sample. The CA sample was selected first, then these participants were removed before VA selection to prevent inclusion in two samples. Four children in the ADHD group were not able to provide a BPVS score, so they were opportunistically matched in the VA group with four typically developing children from our larger dataset who were also missing BPVS data. These four VA group matches were slightly older in chronological age (6 years old, 8 years old, 9 years old and 11 years old respectively) than their ADHD group counterparts (5 years old, 8 years old, 8 years old and 11 years old respectively) although, as Table 1 shows, overall children in the VA group were slightly younger than those in the ADHD group.

T-tests confirmed that the ADHD group did not differ significantly in chronological age (in months) from the CA group $t(58) = .617$, $p = .540$, or in verbal age (in months) from the VA group $t(50) = .682$, $p = .498$. The number of children who completed the easier (24 items; $N = 48$) and more difficult (48 items; $N = 42$) versions of the task was exactly matched across all experimental groups.

The children diagnosed with ADHD were recruited from two local ADHD family support groups ($n = 28$) and one primary school ($n = 2$). All of the children in the ADHD group had either received a medical diagnosis of ADHD ($n = 18$) or had been referred to an ADHD community support group while awaiting diagnosis. We placed no restriction on medication usage. Medication information was received from only a small proportion of participants (reported medications were Biomelotonin, Elvanse, Equisym, Quetiapine and Strattera), so we are unable to characterize medication use across the sample. One child with a co-occurring diagnosis of autism was excluded from the analyses. All of the typically developing children in the matched groups were recruited from local primary schools with parental consent and their own assent. This recruitment process and the experimental procedures were approved by the [redacted UK university] Research Ethics Committee, and all participants provided parental consent and personal assent.

Procedure

Participants were tested individually on three occasions separated by approximately 1 week. In the first meeting, a photograph of the child was taken with a digital camera for use in the SRE task. During Session 2, children completed Cunningham et al.'s (2014) SRE task (modified to include either 28 or 48 items per condition), in which they evaluated whether they or a gender-matched unknown child ('Sam') would like a series of everyday objects (e.g. teddy, apple). Each encoding trial began with either an image of the child's own face (self-referent trial) or Sam's face (other-referent trial) displayed centre-screen for 500 ms, before an object image was co-presented to the left or right for 1500 ms. These images were replaced with a screen showing two buttons depicting a 'smiley' or 'neutral' face, respectively. The participants' task was to indicate whether the referent person would like the object or not, by pressing the appropriate onscreen button. Before the experimental trials began, children completed three practice trials to ensure that they understood the instructions and could evaluate their or Sam's feelings towards the object depicted. All children completed the practice trials successfully.

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Following completion of the encoding trials, a one-step recognition memory test was used to assess the source memory for the images. In each trial, a picture of an object was presented centrally, and the child was asked to use a labelled keyboard button to indicate whether the object had been shown with themselves ('ME'), with Sam ('SAM'), or was a new object that had not been seen before ('NEW'). An equal number of previously unseen foils was included as the number of objects per referent condition (i.e. either 24 or 48). Object images remained onscreen until the child had made a response. The order of old self-referent, old other-referent and new items was randomized by the experimental programme, and the use of objects as self-referenced, other-referenced or new items was counterbalanced across participants.

After the SRE task, each child completed the enactment task (Ross et al., 2011). Participants were shown 24 laminated 'wug' cards (based on Berko's (1958) illustration of a novel, age- and gender-neutral character) one at a time, each depicting a different action (see Figure 1). The experimenter and child took turns to perform the action depicted on the card. Two sets of cards were created to ensure that the actor (i.e. experimenter or child) of each action was counterbalanced across participants. After a 2-min filler task, the children were asked to free recall the actions included in the task, then asked to name the actor (i.e. experimenter or child) who had performed each of the actions recalled.

In the final session, children's verbal mental age was assessed using the British Picture Vocabulary Scale (BPVSIII, Dunn et al., 2009).

RESULTS

Participants' source memory for self-referent and other-referent items was scored by calculating the proportion of hits (i.e. old items correctly identified as being shown with 'me' or 'Sam' respectively) minus the proportion of false alarms (i.e. new items incorrectly identified as being shown with 'me' or 'Sam' respectively), for both the self-referent and other-referent items. These scores were submitted to a 2 (Referent: Self or Other) × 3 (Group: ADHD, VA or CA) × 2 (Difficulty: 24 items or 48 items) mixed ANOVA, which revealed a significant main effect of Group, $F(2, 84) = 14.045$, $p < .001$, $\eta_p^2 = .251$, with post-hoc LSD comparisons showing that the ADHD group remembered a lower proportion of items than both the VA group ($p < .001$) and the CA group ($p < .001$), who did not differ from one another ($p = .625$). There was also a significant main effect of Referent, $F(1, 84) = 5.517$, $p = .021$, $\eta_p^2 = .062$ with more self-referenced items, $M = .53$, $SD = .40$, than other-referenced items, $M = .49$, $SD = 0.37$, being remembered. However, a significant Referent × Group interaction arose $F = 5.499$, $p = .006$, $\eta_p^2 = .116$, which was attributable to a significant SRE arising in both the CA group, self-referenced versus other-referenced $t(29) = 3.657$, $p = .001$, and VA group, $t(29) = 2.358$, $p = .025$, while no SRE was found in the ADHD group, $t(29) = -0.902$, $p = .374$ (see Figure 2). No other effects or interactions reached significance.

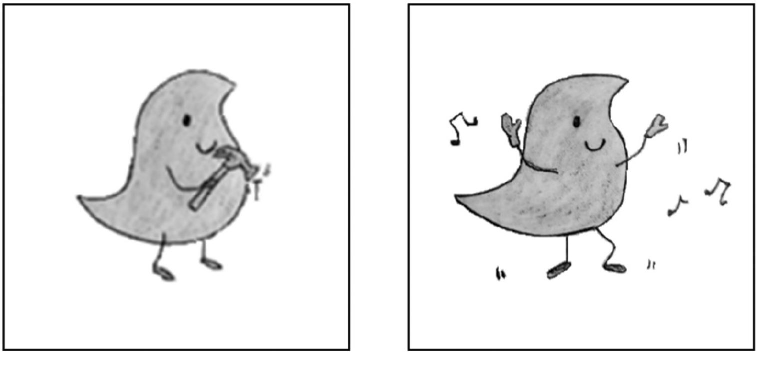

FIGURE 1 Examples of wugs performing actions (hammering, dancing) in the enactment task.

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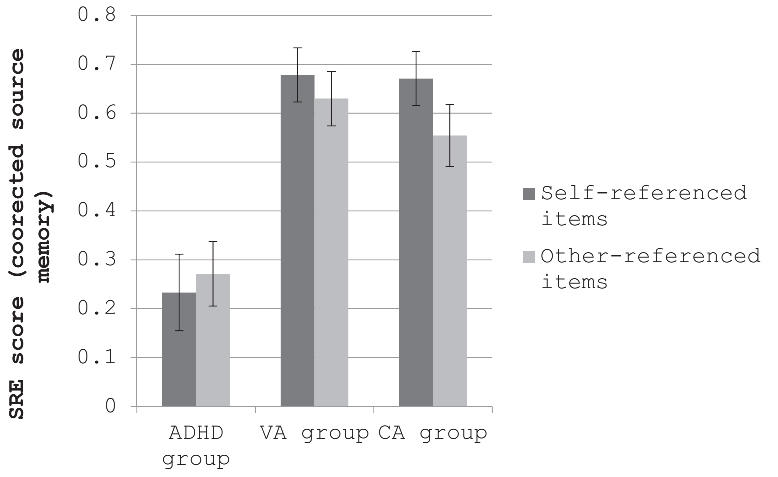

FIGURE 2 Source memory scores for self-referent and other-referent items on the SRE task. (Error bars represent one standard error or the mean.)

Participants' source memory on the enactment task was scored by calculating the proportion of hits for self-performed and other-performed actions (e.g. number of self-items correctly attributed to being conducted by self/12 = total number of self-actions). Three participants in the ADHD group did not complete the enactment task, but all remaining participants were retained in the analysis (N = 87).

Enactment task scores were entered into a 2 (Performer: Self or Other) × 3 (Group: ADHD, VA or CA) mixed ANOVA, which revealed a significant main effect of Performer, $F(1, 84) = 13.390$, $p < .001$, $\eta_p^2 = .137$ with more self-performed actions, $M = .29$, $SD = .24$, than other-performed actions, $M = .19$, $SD = .14$, being recalled. There was an unexpected trend towards a group difference in memory performance, although this did not reach the threshold of significance, $F(2, 84) = 2.971$, $p < .057$, $\eta_p^2 = .066$; VA < ADHD, VA < CA. Importantly there was no interaction between Performer and Group, $F = 0.115$, $p = .891$, $\eta_p^2 = .003$, showing no evidence that the advantage for self-performed actions differed across experimental groups (see Figure 3).

DISCUSSION

The current study examined memory for self- and other-referenced items in a group of children with ADHD and found no evidence of an SRE, whereas robust SREs were shown in typically developing groups of TYD children matched for verbal and chronological age, respectively, across two SRE task difficulty levels. In contrast, a memory advantage for self-performed actions was found in both ADHD and TYD groups.

The lack of SRE in children with ADHD is consistent with the idea that reduced executive functioning, with associated limitation in attentional capacity (Engle, 2002; McCabe et al., 2010), may disrupt SRE production. Attentional input is required to bind incoming information into a cohesive representation in memory, whether it be external elements of the encoding event, or the combination of the event and stored information retrieved in response to the stimulus. For self-referenced items in the SRE task, evaluating the object requires activation of the vast self-knowledge framework (e.g. *I played with that before and liked it*) (Cunningham et al., 2014; Klein & Loftus, 1988; Symons & Johnson, 1997). Binding these elements together creates an elaborate and structured memory trace, which the limited information available to enrich the other-referenced object cannot match. However, limited attentional resources might prevent the same bound encoding from creating a self-referent memory advantage in children with ADHD. Indeed, disruption within the SMS in ADHD might be explained by a threshold point in the continuum of attentional capacity below which SREs cannot be produced.

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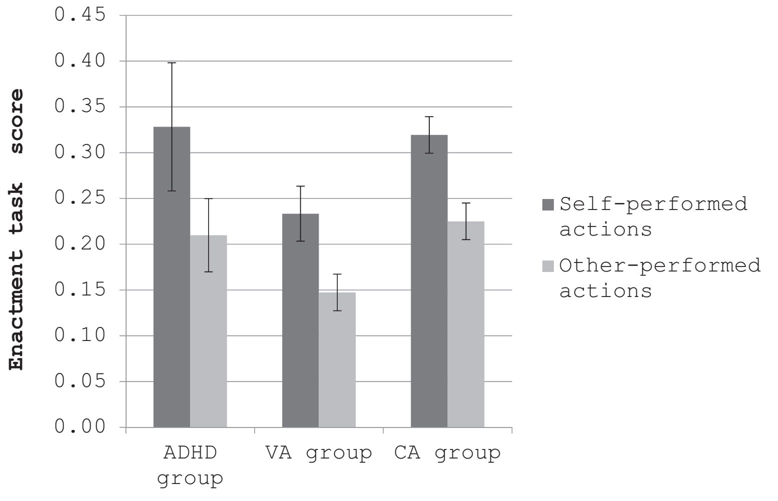

FIGURE 3 Source memory scores for self-performed and other-performed actions in the enactment task. (Error bars represent one standard error of the mean.)

Support for this explanation comes from Turk et al. (2013), who showed that asking participants to do a difficult secondary task during an SRE task eliminates the memory advantage for self-referenced information, suggesting that dividing attention disrupts SRE production. If attention is key to the SRE, the extent to which SREs are produced is likely to vary across individuals and tasks, dependent on attention reserves. Neither Klein et al. (2011) nor the current study were able to provide separate attentional capacity measures, but this is something that should be addressed in the future.

In contrast to the SRE, in enactment tasks, there is no requirement to access the autobiographical memory system at encoding, or to bind aspects of existing self-knowledge or autobiographical memory with the stimulus item for subsequent successful retrieval. Rather, performing an action oneself produces a unique depth of processing that enhances memory (Engelkamp et al., 1994; Engelkamp & Zimmer, 1996). This processing does have cognitive aspects, as implied by the link between enactment and memory. For example, according to the 'person perspective' on action memory (Ratner et al., 2000; Ratner & Foley, 2020), the anticipation, initiation, production and evaluation of one's own actions are mediated by cognitive operations. From this point of view, self-performed actions are better remembered than other-performed actions, in part due to the memory of cognitive operations carried out during encoding. However, this is a consequence of embodied experiences of the selfhood as opposed to requiring a conscious link to knowledge held about the self at the point of encoding.

It should be noted that an additional difference between the SRE and enactment tasks in the current study is that memory in the SRE task was assessed using a source recognition test, whereas memory for actions was assessed using free recall. Previous research with typically developing samples suggests that organization within the self-knowledge framework provides specific retrieval advantages for self-referenced information, via additional routes to retrieval relative to other encoding contexts (Klein & Kihlstrom, 1986; Klein & Loftus, 1988). This retrieval advantage means that the SRE emerges in tests of recollective experience rather than familiarity and, as such, benefits free recall more than recognition (see Conway et al., 2001; Conway & Dewhurst, 1995; van den Bos et al., 2010). However, in the current study, the recognition test used in the SRE task required source attribution, dependent on the retrieval of specific details of the encoding event (i.e. recollective experience; Gardiner, 1988). The finding that a difference between the ADHD and typically developing groups emerged in the SRE task but not the enactment task is therefore unlikely to be attributable to the former being insensitive to retrieval advantages. Rather, the current findings suggest that children with ADHD have a difficulty in the SRE task binding active self-knowledge with multiple items being processed at encoding. In contrast, the

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fact that children in all three groups were able to show a memory advantage for self-performed actions shows that children with ADHD are able to distinguish between self- and other-related memories on the basis of physical action, taking advantage of the additional representation layers provided by action self-generation.

The current findings are not only theoretically interesting, but also have practical ramifications. In particular, the SRE has been shown to be useful in an educational context, where its effects on attention and memory can support children's learning (Cunningham et al., 2018; Turk et al., 2015). Given that an inability to stay task-focused is a notable educational hurdle for children with ADHD, if an SRE had been found, then this would have been a useful learning strategy to engage the children in classroom tasks. It is therefore disappointing to find no SRE shown by children with ADHD. Indeed, a recent study indicated that introducing self-referential stimuli in a classroom context can disrupt sustained attention in children with ADHD, thought to be due to increased susceptibility to self-referential mind wandering (Merrill et al., 2022). Together with Klein et al. (2011), this study suggests that introducing autobiographical reflection may be counterproductive to learning in ADHD.

However, the enactment effect has also been found useful in typically developing classrooms (Hainselin et al., 2017), and our results suggest this paradigm may be more usefully applied to support memory in ADHD. Although the benefits of embodied learning are increasingly recognized in a classroom context, the mechanisms underpinning these benefits are currently under debate (Mathias & von Kriegstein, 2022). Some theories suggest that movement enhances the depth of processing of a memory, increasing the routes to retrieval (sensory, motor, cognitive), while others suggest that moving during learning enhances attention (Proulx et al., 2014). Rather than providing an alternative route to strengthen the memory trace, unaffected by higher-level cognitive processing differences, the latter theory suggests that enactment may directly support attention in ADHD. Further research relevant to classroom applications suggests that tasks using self-cues to elicit attentional prioritization during active processing may be less affected by neurodivergent characteristics than memory-based self-referencing tasks (see Williams et al., 2018). Thus, it is possible that children with ADHD could benefit from the use of self-cues in educational tasks that require active processing, such as numerical problem-solving (see Cunningham et al., 2024). Future research is needed to understand and apply enactment and self-prioritization effects to support learning in different populations and contexts.

In conclusion, the results of the current study show the elimination of the SRE and retention of enactment effects in children with ADHD. This has practical implications for the application of self-referencing in children with ADHD, as well as providing a window into both the developmental impact of ADHD on the self-memory system and the attentional requirements of the SRE in memory.

AUTHOR CONTRIBUTIONS

Zahra Ahmed: Conceptualization; data curation; formal analysis; investigation; methodology; software; writing – original draft. **Sheila J. Cunningham:** Conceptualization; data curation; funding acquisition; methodology; project administration; writing – original draft; formal analysis. **Sinead Rhodes:** Conceptualization; methodology; project administration; resources; writing – original draft. **Ailsa Gow:** Data curation; investigation; writing – review and editing. **Kirsty Macmillan:** Data curation; investigation; writing – review and editing. **Jacqui Hutchison:** Conceptualization; data curation; investigation; methodology; writing – review and editing; software. **Josephine Ross:** Conceptualization; data curation; formal analysis; funding acquisition; methodology; project administration; writing – original draft.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in the Open Science Framework at https://osf.io/3p4zf/?view_only=b8f4e9e1c8b7452bb8f44b0a1979e7a5 (blind review link).

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REFERENCES

Alderson, R. M., Kasper, L. J., Patros, C. H. G., Hudec, K. L., Tarle, S. J., & Lea, S. E. (2014). Working memory deficits in boys with attention deficit/hyperactivity disorder (ADHD): An examination of orthographic coding and episodic buffer processes. *Child Neuropsychology*, *21*(4), 509–530. https://doi.org/10.1080/09297049.2014.917618

Barkley, R. A. (1997). Behavioural inhibition, sustained attention, and executive functions: Constructing a unifying theory of AD/HD. *Psychological Bulletin*, *121*(1), 65–94. https://doi.org/10.1037/0033-2909.121.1.65

Berko, J. (1958). The child's learning of english morphology. *Word*, *14*(2–3), 150–177. https://doi.org/10.1080/00437956.1958.11659661

Boonstra, A. M., Oosterlaan, J., Sergeant, J. A., & Buitelaar, J. K. (2005). Executive functioning in adult ADHD: A meta-analytic review. *Psychological Medicine*, *35*(8), 1097–1108. https://doi.org/10.1017/S003329170500499X

Coghill, D. R., Toplak, M., Rhodes, S., & Adamo, N. (2018). Cognitive functioning in ADHD: Inhibition, memory, temporal discounting, decision-making, timing and reaction time variability. In T. Banaschewski, D. Coghill, & A. Zuddas (Eds.), *Oxford textbook of attention deficit hyperactivity disorder* (pp. 94–102). Oxford University Press.

Cohen, R. L. (1989). Memory for action events: The power of enactment. *Educational Psychological Review*, *1*, 57–80. https://doi.org/10.1007/BF01326550

Conway, M. A., & Dewhurst, S. A. (1995). The self and recollective experience. *Applied Cognitive Psychology*, *9*(1), 1–19. https://doi.org/10.1002/acp.2350090102

Conway, M. A., Dewhurst, S. A., Pearson, N., & Sapute, A. (2001). The self and recollection reconsidered: How a 'failure to replicate' failed and why trace strength accounts of recollection are untenable. *Applied Cognitive Psychology*, *15*(6), 673–686. https://doi.org/10.1002/acp.740

Conway, M. A. (2005). Memory and the self. *Journal of Memory and Language*, *53*(4), 594–628. https://doi.org/10.1016/j.jml.2005.08.005

Conway, M. A., & Pleydell-Pearce, C. W. (2000). The construction of autobiographical memories in the self-memory system. *Psychological Review*, *107*(2), 261–288. https://doi.org/10.1037/0033-295X.107.2.261

Cunningham, S. J., Ahmed, Z., March, J., Golden, K., Wilks, C., Ross, J., & McLean, J. F. (2024). Put you in the problem: Effects of self-pronouns on mathematical problem solving. *Quarterly Journal of Experimental Psychology*, *77*(2), 308–325. https://doi.org/10.1177/17470218231174 22

Cunningham, S. J., Brebner, J. L., Quinn, F., & Turk, D. J. (2014). The self-reference effect on memory in early childhood. *Child Development*, *85*(2), 808–823. https://doi.org/10.1111/cdev.12144

Cunningham, S. J., Scott, L., Hutchison, J., Ross, J., & Martin, D. (2018). Applying self-processing biases in education: Improving learning through ownership. *Journal of Applied Research in Memory and Cognition*, *7*(3), 342–351. https://doi.org/10.1016/j.jarmac.2018.04.004

Dunn, L. M., Dunn, D. M., Sewell, J., Styles, N., Brzyska, B., Shamsan, Y., & Burge, B. (2009). *The British picture vocabulary scale III*. GL Assessment Limited.

Engelkamp, J., & Zimmer, H. D. (1996). Organisation and recall in verbal tasks and in subject-performed tasks. *European Journal of Cognitive Psychology*, *8*(3), 257–273. https://doi.org/10.1080/095414496383086

Engelkamp, J., Zimmer, H. D., Mohr, G., & Sellen, O. (1994). Memory of self-performed tasks: Self-performing during recognition. *Memory & Cognition*, *22*, 34–39. https://doi.org/10.3758/BF03202759

Engle, R. W. (2002). Working memory capacity as executive attention. *Current Directions in Psychological Science*, *11*(1), 19–23. https://doi.org/10.1111/1467-8721.00160

Fabio, R. A., & Caprì, T. (2015). Autobiographical memory in ADHD subtypes. *Journal of Intellectual & Developmental Disability*, *40*(1), 26–36. https://doi.org/10.3109/13668250.2014.983057

Faraone, S. V., Biederman, J., & Mick, E. (2006). The age-dependent decline of attention deficit hyperactivity disorder: A meta-analysis of follow-up studies. *Psychological Medicine*, *36*(2), 159–165. https://doi.org/10.1017/S003329170500471X

2044835x, 0, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1111/bjdp.12489 by University Of Abertay Dundee, Wiley Online Library on [26/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Fuermaier, A. B. M., Tucha, L., Koerts, J., Aschenbrenner, S., Weisbrod, M., Lange, K. W., & Tucha, O. (2013). Source discrimination in adults with attention deficit hyperactivity disorder. *PLoS ONE*, *8*(5), e65134. https://doi.org/10.1371/journal.pone.0065134

Gardiner, J. M. (1988). Functional aspects of recollective experience. *Memory & Cognition*, *16*(4), 309–313. https://doi.org/10.3758/BF03197041

Hainselin, M., Picard, L., Manolli, P., Vankerkore-Candas, S., & Bourdin, B. (2017). Hey teacher, don't leave them kids alone: Action is better for memory than reading. *Frontiers in Psychology*, *8*, 325. https://doi.org/10.3389/fpsyg.2017.00325

Hume, D. (2003). *A treatise of human nature*. Dent. (Original work published 1739).

Humphreys, G. W., & Sui, J. (2016). Attentional control and the self: The self-attention network (SAN). *Cognitive Neuroscience*, *7*(1–4), 5–17. https://doi.org/10.1080/17588928.2015.1044427

James, W. (1890). The consciousness of self. In W. James (Ed.), *Principles of Psychology* (pp. 291–401). Holt.

Klein, S. B., Gangi, C. E., & Lax, M. L. (2011). Memory and self-knowledge in young adults with ADHD. *Self and Identity*, *10*(2), 213–230. https://doi.org/10.1080/15298861003741604

Klein, S. B., & Kihlstrom, J. F. (1986). Elaboration, organization, and the self-reference effect in memory. *Journal of Experimental Psychology: General*, *115*(1), 26–38. https://doi.org/10.1037/0096-3445.115.1.26

Klein, S. B., & Loftus, E. M. (1988). The nature of self-referent encoding: The contribution of elaborative and organizational processes. *Journal of Personality and Social Psychology*, *55*(1), 5–11. https://doi.org/10.1037/0022-3514.55.1.5

Locke, J. (1995). *An essay concerning human understanding*. Retrieved April 7, 2022. http://www.ilt.columbia.edu/publications/locke_understanding.html (Original work published in 1690).

Loe, I. M., & Feldman, H. M. (2007). Academic and educational outcomes of children with ADHD. *Pediatric Psychology*, *32*(6), 643–654. https://doi.org/10.1093/jpepsy/jsl054

Mangels, J. A., Picton, T. W., & Craik, F. I. M. (2001). Attention and successful episodic encoding: An event-related potential study. *Cognitive Brain Research*, *11*(1), 77–95. https://doi.org/10.1016/S0926-6410(00)00066-5

Mathias, B., & von Kriegstein, K. (2022). Enriched learning: Behavior, brain, and computation. *Trends in Cognitive Sciences*, *27*(1), 81–97. https://doi.org/10.1016/j.tics.2022.10.007

McCabe, D. P., Roediger, H. L., McDaniel, M. A., Balota, D. A., & Hambrick, D. Z. (2010). The relationship between working memory capacity and executive functioning: Evidence for a common executive attention construct. *Neuropsychology*, *24*(2), 222–243. https://doi.org/10.1037/a0017619

Merrill, B. M., Raiker, J. S., Mattfeld, A. T., Macphee, F. L., Ramos, M. C., Zhao, X., Altszuler, A. R., Schooler, J. W., Coxe, S., Gnagy, E. M., Greiner, A. R., Coles, E. K., & Pelham, W. E. (2022). Mind-wandering and childhood adhd: Experimental manipulations across laboratory and naturalistic settings. *Research on Child and Adolescent Psychopathology*, *50*, 1139–1149. https://doi.org/10.1007/s10802-022-00912-6

Nieto, M., Ros, L., Ricarte, J. J., & Latorre, J. M. (2018). The role of executive functions in accessing specific autobiographical memories in 3- to 6- year-olds. *Early Childhood Research Quarterly*, *43*, 23–32. https://doi.org/10.1016/j.ecresq.2017.11.004

Polanczyk, G., de Lima, M. S., Horta, B. L., Biederman, J., & Rohde, A. (2007). The worldwide prevalence of ADHD: A systematic review and metaregression analysis. *American Journal of Psychiatry*, *164*(6), 942–948. https://doi.org/10.1176/ajp.2007.164.6.942

Proulx, M. J., Ptito, M., & Amedi, A. (2014). Multisensory integration, sensory substitution and visual rehabilitation. *Neuroscience & Biobehavioral Reviews*, *41*, 1–2. https://doi.org/10.1016/j.neubiorev.2014.03.004

Raiker, J. S., Rapport, M. D., Kofler, M. J., & Sarver, D. E. (2012). Objectively-measured impulsivity and attention-deficit/hyperactivity disorder (ADHD): Testing competing predictions from the working memory and behavioral inhibition models of ADHD. *Journal of Abnormal Child Psychology*, *40*, 699–713. https://doi.org/10.1007/s10802-011-9607-2

Ratner, H. H., & Foley, M. A. (2020). The role of goals and outcomes in young children's memory for actions. *Cognitive Processing*, *21*(3), 411–425. https://doi.org/10.1007/s10339-020-00979-3

Ratner, H. H., Foley, M. A., & Gimpert, N. (2000). Person perspectives on children's memory and learning: What do source-monitoring failures reveal? In K. P. Roberts & M. Blades (Eds.), *Children's source monitoring* (pp. 85–114). Lawrence Erlbaum Associates Publishers.

Rhodes, S. M., Coghill, D., & Matthews, K. M. (2004). Methylphenidate restores visual memory, but not working memory function in attention deficit-hyperkinetic disorder. *Psychopharmacology*, *175*, 319–330. https://doi.org/10.1007/s00213-004-1833-7

Rhodes, S. M., Coghill David, R., & Matthews, K. (2005). Neuropsychological functioning in stimulant-naive boys with hyperkinetic disorder. *Psychological Medicine*, *35*(8), 1109–1120. https://doi.org/10.1017/S0033291705004599

Rhodes, S. M., Park, J., Seth, S., & Coghill, D. R. (2012). A comprehensive investigation of memory impairment in attention deficit hyperactivity disorder and oppositional defiant disorder. *Journal of Child Psychology and Psychiatry*, *53*(2), 128–137. https://doi.org/10.1111/j.1469-7610.2011.02436.x

Rogers, T. B., Kuiper, N. A., & Kirker, W. S. (1977). Self-reference and the encoding of personal information. *Journal of Personality and Social Psychology*, *35*(9), 677–688. https://doi.org/10.1037/0022-3514.35.9.677

Ross, J., Anderson, J. R., & Campbell, R. N. (2011). I remember me: Mnemonic self-reference effects in preschool children. *Monographs of the Society for Research in Child Development*, *76*(3), 1–102. https://doi.org/10.1111/j.1540-5834.2011.00613.x

2044835x, 0, Downloaded from https://bpspsychub.onlinelibrary.wiley.com/doi/10.1111/bjdp.12489 by University Of Abertay Dundee, Wiley Online Library on [26/04/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Ross, J., Cunningham, S. J., & Hutchison, J. (2020). The me in memory: The role of the self in autobiographical memory development. *Child Development*, *91*(2), e299–e314. https://doi.org/10.1111/cdev.13211

Russell, G., Rodgers, L. R., Ukoumunne, O. C., & Ford, T. (2014). Prevalence of parent-reported ASD and ADHD in the UK: Findings from the millennium cohort study. *Journal of Autism and Developmental Disorders*, *44*, 31–40. https://doi.org/10.1007/s10803-013-1849-0

Symons, C. S., & Johnson, B. T. (1997). The self-reference effect in memory: A meta-analysis. *Psychological Bulletin*, *121*(3), 371–394. https://doi.org/10.1037/0033-2909.121.3.371

Turk, D. J., Brady-Van den Bos, M., Collard, P., Gillespie-Smith, K., Conway, M. A., & Cunningham, S. J. (2013). Divided attention selectively impairs memory for self-relevant information. *Memory and Cognition*, *41*, 503–510. https://doi.org/10.3758/s13421-012-0279-0

Turk, D. J., Gillespie-Smith, K., McGowan, L., Havard, C., Conway, M. A., Krigolson, O. E., & Cunningham, S. J. (2015). Selfish learning: The impact of self-referential encoding on children's literacy attainment. *Learning and Instruction*, *40*, 54–60. https://doi.org/10.1016/j.learninstruc.2015.08.001

Van den Bos, M., Cunningham, S. J., Conway, M. A., & Turk, D. J. (2010). Mine to remember: The impact of ownership on recollective experience. *Quarterly Journal of Experimental Psychology*, *63*(6), 1065–1071. https://doi.org/10.1080/17470211003770938

Williams, D. M., Nicholson, T., & Grainger, C. (2018). The self-reference effect on perception: Undiminished in adults with autism and no relation to autism traits. *Autism Research*, *11*(2), 331–341. https://doi.org/10.1002/aur.1891

Zentall, S. S. (1993). Research on the educational implications of attention deficit hyperactivity disorder. *Exceptional Children*, *60*(2), 143–153. https://doi.org/10.1177/001440299306000208

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