ABSTRACT

The self-reference effect (SRE) is the memory enhancement associated with information linked to self. Unlike four- to six-year-olds, adults show stronger memory enhancement when self-processing is ‘evaluative’ (eSRE) than when self-processing is ‘incidental’ (iSRE). Here, the developmental change from shallow to rich self-processing is programmatically explored. In Study 1, six- to eleven-year-olds (N=189) showed an eSRE=iSRE pattern. However, eSRE magnitude was limited by ceiling effects. Avoiding ceiling effects, Study 2 showed a developmentally stable eSRE>iSRE pattern in eight- to eleven-year-olds (N=96; η_p^2=.06). Study 3 uses a different paradigm to confirm that eight- to eleven-year-olds are capable of evaluative encoding, even without concrete self stimuli. However, the evaluative boost for children was smaller than adults’ (N=104, η_p^2=.06). Results are discussed with reference to the developing self, and its capacity to support memory.

KEYWORDS: self, memory, development, self-reference effect, eSRE, iSRE

Development of evaluative and incidental self reference effects in childhood

The self is a fundamental construct in human cognition, associated with numerous biases in perception, attention and memory (Cunningham & Turk, 2017). One well-studied example is the memory advantage known as the self-reference effect (SRE), which describes the tendency for self-relevant information to be remembered better over information encoded with reference to other people, or in non-social contexts, (Conway & Dewhurst, 1995; Klein & Loftus, 1988; Rogers et al., 1977; Symons & Johnson, 1997; Turk et al., 2008). While the influence of the self on memory is well understood in adulthood, the mnemonic impact of the self-concept has been under-researched in childhood (Ross et al., 2011). This omission is striking because a qualitative difference between the SREs of young children and adults has been proposed (Cunningham et al., 2014), linked to functional changes in the developing self-concept (Ross et al., 2019). The current study is designed to address this gap by charting SRE development across the critical period of middle to late childhood.

Self Reference Effect

The SRE is thought to arise as a function of multiple cognitive biases, which can be considered in two broad categories (Turk et al., 2008). First, there is the self-knowledge framework, the store of autobiographical memories that is activated when thinking about oneself, which can be used to elaborate and organise incoming self-relevant information (Klein & Kihlstrom, 1986; Klein & Loftus, 1988; Symons & Johnston, 1997). Second, there are automatic attentional responses to self-cues that ensure self-relevant material is preferentially processed, with self-relevant stimuli being perceive more quickly, and capturing and sustaining attention (Brédart et al., 2006; Humphreys & Sui, 2016; Kelley et al., 2002; Kesebir & Oishi, 2010; Sui et al., 2013). The SRE can therefore be supported by both activation of existing self-knowledge structures, and low-level processing biases elicited by self-relevant cues.

The self knowledge-based and attention-based systems may be activated to varying degrees by different self-referencing tasks. The standard SRE paradigm uses self-evaluation of abstract trait adjectives to elicit a mnemonic self-bias (Rogers et al., 1977). Participants are typically asked to encode several trait words in the context "*Does this word describe you*?" (self-referent context), "*Does this word describe [famous person]?*" (other-referent context), or "*Does this word mean the same as [different adjective]*?" (semantic context). Memory for the trait words shows a robust advantage for those encoded with reference to the self, relative to those encoded in the other-referent or semantic contexts (see Symons & Johnson, 1997, for meta-analytic review). Participants in the trait evaluation task are consciously processing information with reference to their self-knowledge, so it is unsurprising that the SRE elicited in these studies shows features of elaboration and organisational support by the self-knowledge framework (Klein & Loftus, 1988). The SRE that results from tasks like this, which require evaluation of self-knowledge at encoding, is hereafter referred to as an **'evaluative SRE'** (eSRE).

In addition to eSREs, there are self-memory advantages that are not dependent on conscious evaluation of self-related information but arise from very minimal associations with self (Cunningham et al., 2008; Turk et al., 2008; Ross et al., 2011). A feature of these tasks is that the identity of the referent presented with the item is purely incidental, hence the resultant memory advantage for self-referenced items is referred to as an **'incidental SRE'** (iSRE). For example, Turk et al. (2008) asked adult participants to complete the standard trait evaluation task (i.e., an eSRE task) where they saw either their own face or an unknown face paired with a trait adjective, and were asked to judge whether the trait was reflective of the referent with whom it was presented (self or other). Participants in an incidental version of this encoding task (i.e., an iSRE task) saw the same stimuli but were instead asked to judge the spatial location of the trait adjective (above or below the face). Participants in both conditions showed a memory advantage for information presented with their own face, however the eSRE task elicited a greater self-advantage than the iSRE task (eSRE > iSRE). The authors suggested this pattern arose because both the eSRE and iSRE evoke memory-enhancing attentional biases to self-relevant stimuli, but only the eSRE task benefitted from the additional mechanism of support and elaboration by the self-knowledge framework, boosting the memory advantage in this condition.

SRE development

Interestingly, the logical pattern of eSRE > iSRE is not replicated in early childhood research. Indeed, the onset of eSREs across childhood has proved difficult to determine, with different tasks producing different age patterns. Of the limited number of studies applying the trait evaluation paradigm in children, some lend support to the idea that the mnemonic consequences of evaluative self-reflection amplify with age, noting developmental increases in the size of the eSRE up to late childhood (Halpin et al., 1984; Ray et al., 2009). However, there are also reports of a stable eSRE magnitude across middle childhood (Bennett & Sani, 2008; Pullyblank et al., 1985). These findings are difficult to interpret because prior to around eight years of age, children may struggle with trait evaluation tasks as a result of difficulties processing abstract character traits. Although young children can provide consistent self-descriptions, these tend to focus on concrete aspects of the self (e.g. physical appearance) rather than abstract characteristics (Eder, 1989; Harter, 2012; Montmayer & Eisen, 1977). Further, there is no strong evidence to suggest that young children spontaneously engage in abstract self-reflection. Even when trait words (such as ‘clever’) are used to describe the self, when asked to justify these, children tend to refer to specific experiences rather than reflecting the global quality of past behaviour or likely future behaviour (Harter, 1999; Damon & Hart, 1988). This implies that prior to around eight years, children's understanding and use of trait adjectives may be psychologically immature. While this processing change may contribute to mixed findings concerning the eSRE in middle childhood, an adult-level eSRE pattern seems to be well-established by about ten years of age (Halpin et al., 1984; Pullyblank et al., 1985), with children able to apply their self-knowledge to the support of incoming information.

In contrast to the mixed reporting of developmental effects in the eSRE, there is a consistency to reports of a stable iSRE emerging in early childhood (Cunningham et al., 2013; Cunningham, et al., 2014; Ross et al., 2011; Sui & Zhu, 2005). For example, Sui and Zhu (2005) presented children with a series of paired images showing their own or another referent's face atop a stick figure pointing at an object. The child's task was to identify who had been pointing at the object, rather than evaluating the object. A subsequent free recall task showed an advantage for self-referenced items (an iSRE) in children over five years. Dunbar et al. (2016) used the same procedure in four- to six-year olds and found an iSRE in source memory that was developmentally stable across this stage. Further, Andrews et al. (2020) adapted the procedure to include self-referent images, other-referent images, and dogs at encoding, testing recognition of multiple combinations to examine levels of binding. They found significant iSREs in four- to six-year-olds for discrimination of items, referents, and bound representations, and again the magnitude of these effects did not vary with age. Finally, Maire et al. (2020) recently showed an age-invariant processing advantage for stimuli associated with self in middle childhood. In this study, children aged six to ten years learned pairings between referents (self, friend, stranger) and vacation spot images. They subsequently completed a matching task in which pairs of images were presented (e.g., self-image with an igloo), and the child was asked whether or not the combination was correct

(Sui et al., 2012). Both response time and accuracy data showed an advantage for images paired with self, and the magnitude of this effect was found to be age-invariant. Together, these studies provide evidence that the self-referent processing biases underpinning the iSRE are stable across early and middle childhood. This evidence supports the reasoning that iSREs emerge early and do not vary in magnitude with age, driven by developmentally stable self-processing biases rather than the maturing self-memory system.

Patterns of early eSRE and iSREs were assessed systematically by Cunningham et al. (2014), who examined four- to six-year-old children's memory performance on an adapted version of the trait evaluation paradigm. The adapted version involved replacing the trait adjective judgement with a more age-appropriate concrete task, in the form of assessing toys and household objects for desirability. Subsequent recognition and source memory showed a reliable memorial advantage for objects processed with self (an eSRE), which was age invariant across this early childhood stage. In an iSRE version of the task, children were shown exactly the same stimuli but rather than evaluating each object, they were simply asked to report its spatial location. Again, results showed a stable memory advantage for objects presented with self (an iSRE). Interestingly, Cunningham et al. found that the magnitude of the self-referential advantage was similar in both the evaluative and incidental tasks (eSRE = iSRE). This pattern was recently replicated in four- to six-year-old children by Ross et al. (2020), suggesting it is robust in early childhood, but contrasts with the adult pattern in which the self-reference effect was greater after evaluative task (Turk et al., 2008).

A clear explanation for the contrasting pattern of eSREs and iSREs in early childhood (eSRE = iSRE) and adulthood (eSRE > iSRE) is that the eSRE in adulthood is boosted by a rich and cohesive sense of self that has not yet developed in younger children. Theoretically, iSREs could be possible from the point of objective self-awareness, which is established by approximately two years of age, when children demonstrate signs such as mirror recognition

(Courage et al., 2004) and the use of personal pronouns (I, me, mine: Hay, 2006). However, children do not express stable, global self-evaluations (i.e. assessments of dispositional behaviour, personality traits, and self-worth) until around eight years of age (Harter, 1999). It might be expected that this maturation in self-awareness would impact on eSRE task performance, with children becoming able to benefit from both low level processing (attention drawn to self-referent stimuli) and high level processing (evaluating how the stimulus fits with the self-concept).

One possible developmental pattern is that there is a qualitative shift in children's eSRE elicitation as the self-concept moves from concrete to abstract at around eight years of age. If this were the case, we would expect to see a switch from equal iSRE and eSRE magnitudes below the age of 8 years, to an adult-like eSRE > iSRE pattern (Turk et al., 2008) in middle childhood. However, it is also possible that the eSRE continues to grow in magnitude (relative to the iSRE) across the lifespan, in line with an incrementally increasing autobiographical memory store and episodic encoding abilities (Raj & Bell, 2010). Individuals build a greater body of experiences and self-knowledge across time, providing ever-increasing scope to elaborate incoming self-relevant information (Klein & Loftus, 1988). Further, with cognitive development comes increasing ability to bind information (Drummey & Newcombe, 2002; Ghetti & Lee, 2011; Raj & Bell, 2010). These developments provide potential for the self-knowledge framework to more effectively store and organise self-referenced material (Klein & Kihlstrom, 1986) which may lead to a gradual linear relation between eSRE development and age. Note, these possibilities are not incompatible, given that the switch to eSRE>iSRE in both cases depends on age-related cognitive changes.

Current inquiry

Extant research suggests some predictions for the development of SREs across middle childhood. The iSRE should remain relatively stable, given that the self-processing biases assumed to underpin it are likely to be in place after the onset of objective self-awareness. In contrast, the eSRE would be expected to undergo age related change, as an incrementally increasing store of autobiographical memories and self-knowledge may give rise to an increase in the eSRE relative to iSRE across middle childhood, ultimately resulting in the adult pattern of significantly larger eSRE than iSRE (Turk, et al, 2008). However, it is an open question when this switch occurs. This is important given that eSRE and iSRE tasks can produce self-reference effects based on lower level processes, meaning that to date, we have no reliable evidence to suggest that young children benefit from self-evaluative processing. This is necessary to evidence the onset of mature self-reference effects, thought to be necessary for the construction and maintenance of a personal life narrative (Conway & Dewhurst, 1995).

We report three studies examining the development of eSREs and iSREs across childhood. Study 1 applies Cunningham et al.'s (2014) established concrete SRE tasks to measure the eSRE and iSRE in six- to eleven-year-old children. In Study 2, we calibrate the tasks to better observe changes in the magnitude of the self-reference effect in the focal age range; eight- to eleven-year-old children. Finally, in Study 3, we directly compare adults and eight- to eleven-year-old's performance on a purely evaluative processing task, the standard trait paradigm.

Study 1

Method

Participants

The original sample comprised 197 children aged 6–11 years. However, we excluded eight participants scoring more than three standard deviations above the mean for self (three) or other items (five), leaving a final sample of 189 children. This sample was divided into three age categories comprising seventy-three 6-7 year olds (47.9% male, age range = 72-95 months, M_{age} = 84.0 months; 39 eSRE, 34 iSRE), fifty-nine 8-9 year olds (35.6% male, age range = 96-119 months, M_{age} = 107.4 months; 30 eSRE, 29 iSRE) and fifty-seven 10-11 year olds (52.6% male, age range = 120-142 months, M_{age} = 129.9 months; 29 eSRE, 28 iSRE). Participants were randomly assigned to either the eSRE (n = 98) or iSRE (n = 91) condition. Independent samples t-tests confirmed that iSRE and eSRE samples were matched for age in months within each age group (6-7 year olds, $t(71)= 0.40$, $p = .689$; 8-9 year olds, $t(57) = 0.42$, $p = 0.676$; 10-11 year olds, $t(55) = 0.32$, $p = .749$). All children had English as a first language and were pupils at local nurseries or schools. Race and SES data were not collected but the children were recruited from predominantly White, lower to middle class Scottish areas. The children were tested with the written consent of a parent or guardian, and their own assent.

Procedure

The children were tested individually across two sessions. At the end of each session, the child was thanked, given a sticker, and returned to class. During Session 1 participants were introduced to the experimenter and the participant’s photograph was taken for use in the SRE task (either eSRE or iSRE; Cunningham et al., 2014), which was conducted in Session 2.

Materials

SRE task**.** The self-referent cue was created using the photograph taken in Session one. Each image was edited using picture editing software with the final image being the child's face on a transparent background (250 x 250 pixel, 72 dpi). Facial photographs of unknown others were similarly modified to create sex and age-matched other-referent cues with the unisex name 'Sam'. The experiment was run on a 15" ASUS touchscreen laptop using EPrime experimental software and consisted of an encoding task followed by a surprise memory test.

The encoding phase consisted of 72 trials with 36 self-referent (child's own face) trials and 36 other-referent (unknown other face). Each trial consisted of a face that was presented on a white background in the centre for 2,000 ms. Trials were randomized across the encoding phase. During each trial 500ms after the onset of the face an object was shown in a box to the left or right of the face and remained onscreen for 1,500 ms. There were 72 objects in total (e.g., cup, cheese) and each object was a color image on a white background (250 x 250 pixels, 72 dpi). The presented objects were taken from a total of 108, divided into 3 equal lists: self-referent, other-referent, foils. Only self and other referent lists were used in the encoding phase; the foils were added in the subsequent memory test. The three lists were counterbalanced across participants.

In the eSRE task children were asked, "Would you [Sam] like this object, or would you [Sam] not really like it?". The face and object remained onscreen together for 1,500 ms, then a 100-ms blank interstimulus interval preceded presentation of two yellow circle "buttons" depicting a smiley face and a neutral face. The children were asked to indicate their response by touching the smiley face or neutral face. After each response, the faces disappeared and a blank 1,000 ms interval preceded presentation of the next trial. Trials were self-paced. Three practice trials preceded the encoding trials.

The stimuli and procedure for the iSRE encoding task were identical to that of the eSRE version, with the exception that instead of being asked to evaluate each object with reference to the self or the other-referent, the children were asked to report on which side of the screen the object had been presented. Here they were presented with two blank yellow buttons instead of a smiley and neutral face, one button on each side of the screen.

The memory phase was identical for both task versions. This comprised a total of 108 trials. Each trial comprised a centrally presented object (36 self-referent, 36 other-referent, 36 foils) and the children were asked to respond to each picture with one of the following answers: “New picture”, “Shown with me” or “Shown with Sam”. Responses were indicated by a key press on the keyboard where keys were annotated with “New” “Me” “Sam”. The children were advised they could guess if they were unsure of the answer. Once the child had made their response the object disappeared and a 1,000ms inter-trial interval preceded presentation of the next object. Trials were self-paced.

Scoring for SRE task. Following Cunningham et al. (2014), SRE task performance was scored by calculating the source memory score, corrected for guessing using the false alarm rate. The self-referent score was calculated by subtracting the proportion of “self” false alarm rate (New items incorrectly identified as “Shown with me”) from the proportion of “self” hits (Self items correctly identified as “Shown with me”). The other-referent score was calculated by subtracting “other” false alarm rate (New items incorrectly identified as “Shown with Sam”) from “other” hits (New items correctly identified as “Shown with Sam”). Mean difference scores (M_{diff}) can be calculated by subtracting corrected source scores for “other” items from corrected source scores for “self” items, to show the magnitude of the self-reference effect.

Results

Uncorrected task scores (hit rates and false alarms) are presented in Table 1.

To examine SRE task performance, source memory scores were submitted to a 2 (SRE Task: evaluative, incidental) x 3 (Age group: 6-7yrs, 8-9yrs, 10-11yrs) x 2 (Referent: self, other) mixed model ANOVA, with Referent being the repeated measures factor.

The was a main effect of SRE task $F(1, 183) = 413.30$, $p < .001$, partial $\eta^2 = .69$ with better source memory in the evaluative SRE task ($M = .80$, $SE = .01$) relative to the incidental SRE task ($M = .40$, $SE = .01$). There was also a main effect of age $F(2, 183) = 3.56$, $p = .030$, partial $\eta^2 = .04$ with post hoc Bonferroni tests confirming significant improvement in overall source memory between 6-7 yr olds ($M = .56$, $SE = .02$) and 10-11yr olds ($M = .63$, $SE = .02$; $p = .027$) but no significant difference between 6-7 yr olds and 8-9 yr olds ($M = .60$, $SE = .02$; $p = .418$) or 8-9 yr olds and 10-11 yr olds ($p = .793$). The main effect for referent $F(1, 183) = 65.45$, $p < .001$, partial $\eta^2 = .26$ found source memory to be better for self-referent items ($M = .64$, $SE = .01$) relative to other-referent items ($M = .55$, $SE = .01$).

Table 1

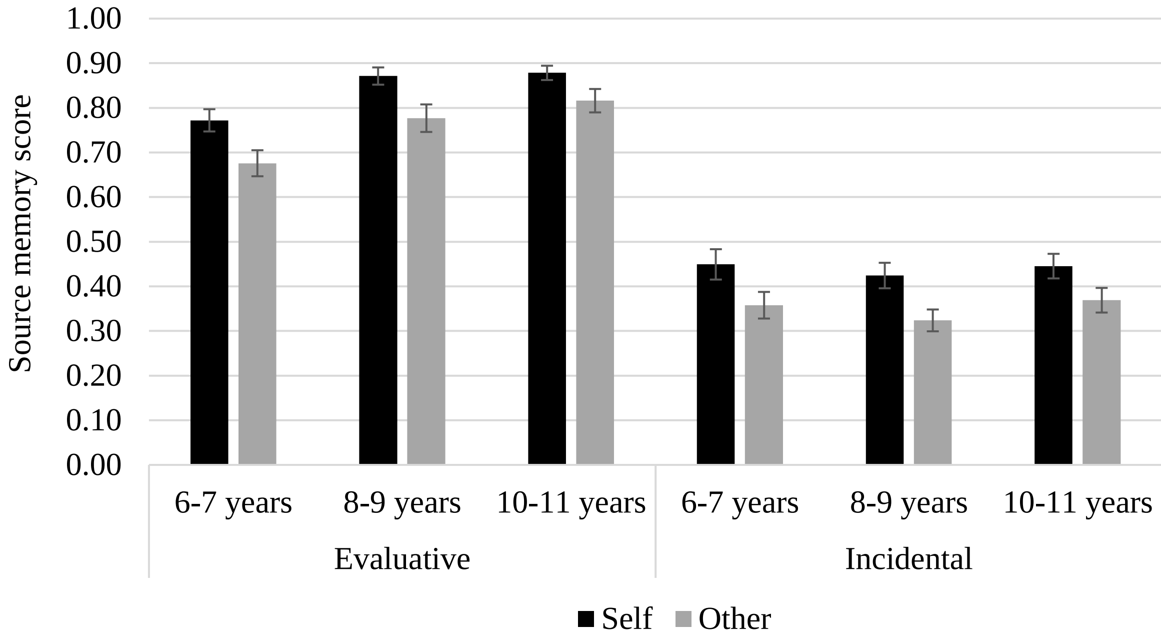
Uncorrected Hit and False Alarm rates by age in the eSRE and iSRE task (Study 1).

	Evaluative SRE task				**Incidental SRE task**			
	Self Referent		Other referent		Self Referent		Other referent	
	Hits	FAs	Hits	FAs	Hits	FAs	Hits	FAs
6-7 years	0.79	0.02	0.70	0.02	0.47	0.02	0.37	0.02
8-9 years	0.88	0.01	0.78	0.01	0.45	0.02	0.35	0.03
10-11 year	0.89	0.01	0.82	0.01	0.48	0.03	0.40	0.04

There was a significant Age Group x SRE Task interaction $F(2, 183) = 4.75$, $p = .010$, partial $\eta^2 = .05$. Simple effects analysis showed this interaction was driven by a significant age-related increase in the mean evaluative source memory score from 6-7 years ($M = .72$, $SE = .02$) to 8-9 years ($M = .82$, $SE = .03$; $t(67) = 2.88$, $p = .005$; $d = .71$), which then stabilised with no reliable change from 8-9 years to 10-11 years ($M = .85$, $SE = .03$; $t(57) = 0.78$, $p = .441$; $d = .20$). In contrast, we see no age-related change in the mean incidental SRE from 6-7 yr olds ($M = .40$, $SE = .02$) to 8-9 yr olds ($M = .37$, $SE = .03$; $t(61) = 0.82$, $p = .413$; $d = .21$), nor from 8-9 to 10-11 yr olds ($M = .41$, $SE = .03$; $t(55) = 0.97$, $p = .338$; $d = .26$). No other two way interactions were significant, Referent x Age Group interaction $F(2, 183) = .64$, $p = .527$, partial $\eta^2 = .01$; Referent x SRE Task interaction $F(1, 183) = .06$, $p = .809$, partial $\eta^2 = .00$. Importantly there was no evidence of a Referent x SRE Task x Age Group interaction, $F(1, 183) = .07$, $p = .\ 935$, partial $\eta^2 = .001$, suggesting there were no reliable age-related changes in the difference of SRE magnitude between the eSRE and iSRE (see Figure 1).

Figure 1

Source memory scores for Self referent and Other referent items on the eSRE and iSRE task, split by age group (Study 1). (Error bars represent one standard error of the mean).



Confirming the absence of a linear developmental association between SRE magnitude and age, there was no correlation between age (in months) and the magnitude of the SRE in either the evaluative task ($r(98) = -.144$, $p = .156$) or incidental SRE task ($r(91) = -.074$, $p = .488$).

Discussion

Study 1 was designed to chart eSREs, iSREs and self-concept development in children aged six- to eleven-years-old. As expected, we found reliable SREs in both evaluative and incidental tasks, with self-referenced items being better remembered than other-referenced items. While overall SRE task performance increased with age, this pattern did not differ across referent, so there was no developmental increase in the magnitude of the SRE across this age group. Importantly, this pattern did not differ across SRE type; as the correlation analysis confirmed, both the eSRE and iSRE were age-invariant in the current study.

An interaction between SRE type and age group was broken down to reveal that source memory in the eSRE task (across self-and other-referenced items) increased significantly from the six- to seven-year-old to the eight- to nine-year-olds but was stable thereafter. In contrast, there was no developmental increase in iSRE task performance across self- and other-referenced items. The age-related change in total memory arising in the evaluative condition might reflect a general age-related increase in source memory (Drummey & Newcombe, 2002; Ghetti & Lee, 2011; Raj & Bell, 2010), but we did not observe a developmental increase in source memory in the incidental version of the task, where the source memory demands were matched. This implies that the increase is a product of the encoding condition in which increasingly complex self-and other-constructs allow person information (whether self-or other-referent) to be bound to the representations of the encoding event.

The pattern of eSRE development found in Study 1 was unexpected. We predicted that we might see an additive value of self-referent processing in the eSRE relative to the iSRE, at least by around eight years, but instead the group-level analysis showed that the magnitude of both self-reference effects was age invariant across six to eleven years. However, examination of source memory means suggested that age-related changes in the magnitude of the SRE may have been masked by ceiling effects in Study 1. As performance approaches ceiling in other-referent processing conditions (observed here for older children), the magnitude of the self-bias is constrained. For example, the magnitude of the eSRE in the six- to seven-year-old group represented just over three items, with a mean of 28.4 (79%) self-referenced items and 25.2 (70%) other-referenced items correctly recognised. In order to increase by even one item per age group, the ten- to eleven-year olds' memory for self-referenced items would need to average 34.7 items (96%) of the 36 presented in this condition, a figure that is less than one standard deviation from the maximum possible score.

Ceiling effects in Study 1 therefore reduced the capacity for the eSRE magnitude to increase with age**.** Six- to seven-year-olds' performance was not constrained by ceiling effects; nonetheless there was no evidence of a higher eSRE than iSRE, replicating patterns previously reported in studies with children up to six years old (Cunningham et al, 2014; Ross et al, 2020), and so it seems reasonable to conclude that younger children (i.e., up to six-seven years of age) do not show an additive memory value of evaluative over incidental self-processing. However, we can make no strong conclusions about the development of iSRE and eSREs beyond the age of 7 years based on this data. To address this open question, a second study was conducted in which we adapted the tasks to minimise chances of ceiling effects for older children.

Study 2

In Study 1, the number of trials in the SRE encoding task was increased from the 72-item set (24 items per condition) used in previous research with younger children (Cunningham et al., 2014; Ross et al., 2020) to a 108-item set (36 items per condition) in an attempt to reduce the chances of ceiling effects in this wider age range. However, because ceiling was an issue in the older age group, for Study 2 we used a 144-item stimulus set (48 items per condition). Unfortunately, piloting indicated that increasingly the volume of to-be-remembered information meant the task did not sustain the attention of children younger than seven years. However, given that the eSRE = iSRE pattern has now been replicated three times (Cunningham et al, 2014; Ross et al., 2020; Study 1) using age appropriate stimulus sets for younger children, we considered it more critical to offer eight- to eleven-year-olds an age appropriate test. Given age related change in overall scores at the age of 8 years in the eSRE (but not iSRE) task, we expected to find that, unconstrained by ceiling effects, children over the age of eight years would show age related change in the magnitude of the eSRE, and larger eSRE than iSRE effects.

Method

Participants

The original sample comprised 98 participants aged 8-11 years. However, we excluded two participants scoring more than three standard deviations above the mean for self (one) or other items (one), leaving a final sample of 96 participants. This sample was divided into two age categories comprising fifty-one 8-9 year olds (54.9% male, age range = 97-119 months, M_{age} = 110.4 months; 26 eSRE, 25 eSRE) and forty-five 10-11 year olds (51.1% male, age range = 120-143 months, M_{age} = 131.3 months; 24 eSRE, 21 iSRE). Participants were randomly assigned to either the eSRE (n = 50) or iSRE (n = 46) condition. Independent samples t-tests confirmed that iSRE and eSRE samples were matched for age in months within each age group (8-9 year olds, $t(47) = 0.04$, $p = .967$; 10-11 year olds, $t(42) = 0.99$, $p = .330$ [note three missing data points for age in months]). All children had English as a first language and were pupils at local schools. Race and SES data were not collected but the children were recruited from predominantly White, lower to middle class Scottish areas. The children were tested with the written consent of a parent or guardian, and their own assent.

Materials and procedure

Each participant completed either the eSRE or iSRE task from Study 1, adapted to have 48 self-referent and 48 other-referent items at encoding, with a further 48 items reserved for foils in the memory test. The use of items as self-referenced stimuli, other-referenced stimuli and foils was counterbalanced across participants. After completion of the eSRE or iSRE task participants were thanked and debriefed.

Results

Hits and False Alarm rates are summarised in Table 2.

Table 2

Uncorrected Hit and False Alarm rates by age in the eSRE and iSRE task (Study 2).

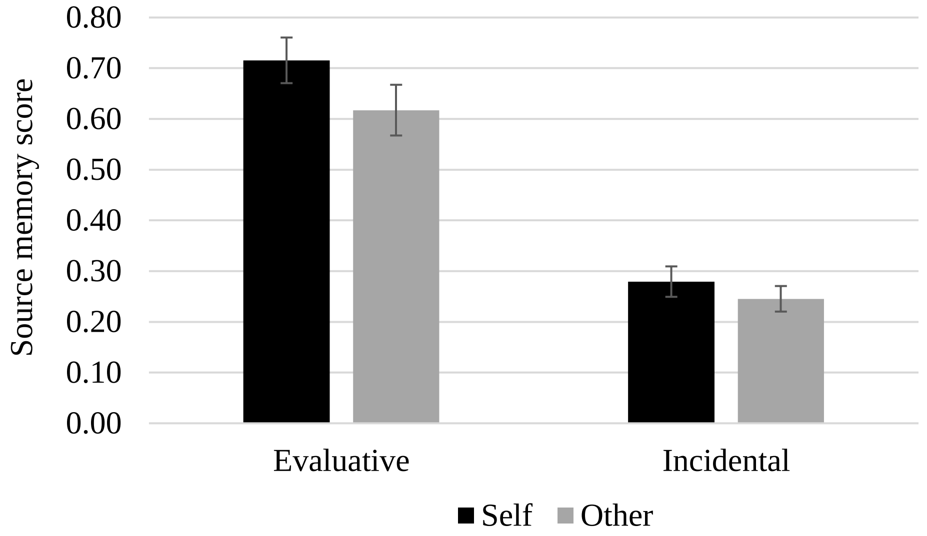
	Evaluative SRE task				**Incidental SRE task**			
	Self Referent		Other referent		Self Referent		Other referent	
	Hits	FAs	Hits	FAs	Hits	FAs	Hits	FAs
8-9 years	0.74	0.08	0.66	0.15	0.42	0.12	0.34	0.09
10-11 years	0.75	0.04	0.68	0.07	0.43	0.18	0.35	0.12

Source memory scores were submitted to a 2 (SRE Task: evaluative, incidental) x 2 (Age: 8-9 yrs, 10-11 yrs) x 2 (Referent: self, other) mixed model ANOVA with SRE task and Age as between subjects factors. As in Study 1, source memory was significantly better in the evaluative SRE task (M = .67, SE = .04) relative to the incidental SRE task (M = .26, SE = .04), $F(1, 92) = 51.16$, $p < .001$, partial $\eta^2 = .36$; and for self-referent items (M = .50, SE = .03) relative to other-referent items (M = .43, SE = .03), $F(1, 92) = 22.39$, $p < .001$, partial $\eta^2 = .20$. However, there was no significant increase in overall memory performance with age $F(1, 92) = 0.112$, $p = .740$, partial $\eta^2 = .001$.

There was a significant Referent x SRE Task interaction, $F(1, 92) = 5.67$, $p = .020$, partial $\eta^2 = .06$. Simple effects analysis revealed that while both evaluative and incidental SRE tasks showed better memory for self-referent relative to other-referent items, the magnitude of the effect was significantly greater in the evaluative relative to the incidental task (see Figure 2; eSRE $M_{diff} = .10$, $SE = .02$; iSRE $M_{diff} = .03$, $SE = .02$, $t(94) = 2.35$, $p = .021$; $d = .48$).

Figure 2

Source memory scores for Self referent and Other referent items on the eSRE and iSRE task (Study 2). (Error bars represent one standard error of the mean).



No other two-way interactions approached significance: Referent x Age Group interaction $F(1, 92) = 0.56$, $p = .456$, partial $\eta^2 = .006$; Age Group x SRE task interaction $F(1, 92) = 0.08$, $p = .772$, partial $\eta^2 = .001$. As in Study 1, the three-way Referent x Age Group x SRE task interaction was also non-significant, $F(1, 92) = 0.25$, $p = .620$, partial $\eta^2 = .003$, meaning that there were no reliable age-related changes in the difference of SRE magnitude between the evaluative and incidental SRE tasks.

Confirming the absence of a linear developmental association between SRE magnitude and age, there was no correlation between age (in months; note this data was missing for three participants) and the magnitude of the SRE in either the evaluative task ($r(50) = .034$, $p = .816$) or incidental SRE task ($r(43) = -.113$, $p = .470$).

Discussion

Study 2 provided evidence of an adult SRE pattern in childhood for the first time, with eight- to eleven-year-old children showing a significantly greater memory enhancement for self-referenced items under evaluative than incidental encoding conditions. Unlike Study 1, the children's task performance was not curtailed by ceiling effects, and this allowed detection of a clear eSRE > iSRE pattern, confirming our predictions that children should be able to benefit from evaluative self-reference from around eight years of age, based on their mature self-concept.

The findings from Study 2 are the first to demonstrate eSREs in this age group using an evaluative SRE task based on the processing of concrete stimuli rather than abstract trait characteristics. The fact that this effect was found to be age-invariant is interesting. Previous research using the more traditional trait evaluation task to examine self reference (e.g., *"Does this word describe you today?"*; Pullyblank et al.,1985) has produce mixed findings with some reports of an age-invariant SRE, and others of an increasing SRE with age. Examination of the samples and methodology of these studies reveals some interesting differences that may contribute towards the mixed results. Of the studies reporting age-invariant eSREs across middle childhood, Pullyblank et al. tested seven- to eleven-year-old children and adults (encoding conditions: self reference vs. semantic encoding) and found a similar SRE across the age groups. Similarly, Bennett and Sani (2008) tested five-year-old, seven-year-old, and ten-year-old children on six different encoding conditions (including self-reference and semantic encoding, but not other-reference). They found no interaction between task type and age, although interpretation of patterns is difficult because age is only examined against a single six-level factor, and no broken-down data is available. It seems reasonable to posit on the basis of the Pullyblank et al. (1985) findings, along with the results of Study 2, that a developmentally stable eSRE is established from about eight years of age.

On closer inspection, contrary previous reports of an increasing eSRE across middle childhood do not challenge this position. Halpin et al. (1984) tested a sample of three age groups with a mean age of six years, seven years, and ten years respectively on a self-reference, semantic and acoustic sound task. An SRE emerged only in the oldest group, so children younger than eight years of age did not show a reliable eSRE. Given the issues discussed above regarding testing young children on abstract evaluation tasks, this finding does not seem surprising; unfortunately, no comparison group older than seven years was included in this study, so later developmental changes cannot be examined. In the remaining study to test eSREs in children, Ray et al. (2009) examined self-reference (*"Is this word like you?"*) in comparison to mother-reference (*"Is this word like Mom?"*) and semantic encoding conditions in seven- to thirteen-year-olds. Ray et al. report a developmental increase in SRE (as measured by memory for self-referenced vs. mother-referenced words), driven by an age-related increase in recall of psychological words referenced to self, but not those referenced to mother. However, this pattern may reflect an increasing psychological distance from mother across middle childhood rather than an increasing eSRE, as semantic recall also increased in line with self-referential recall and there is no age-related difference between these two encoding conditions.

Weighing up the findings of previous research and the current study, there seems little evidence of a reliable age-related increase in eSREs across this time. However, there are also gaps in the research that undermine this conclusion. In particular, there is no existing developmental work that systematically compares self-reference to other-reference (unconfounded by close relationships) in eSRE tasks. Further, there is only one previous study examining how the eSREs at the end of middle childhood (i.e., 10-11 years) compare to adult eSREs (Pullyblank et al., 1985), and this study did not contrast self-referencing with other-referencing, but with semantic encoding conditions. Finally, while the concrete eSRE task used in Studies 1 and 2 are designed to be comparable to the standard trait eSRE task, the task difference may contribute to the reported lack of developmental increase. The level of evaluation required by children in the concrete tasks is relatively simple (based on likes and dislikes rather than more complex personality traits), and the presence of own face in both eSRE and iSRE conditions means that age invariant lower level processes (such as attention) contribute to performance in both tasks. Study 3 was therefore designed to examine eSRE development from eight years to adulthood, using a trait evaluation task. This task did not include the child's face, and so, unlike the concrete eSRE task, relied entirely on high level self-evaluation.

Study 3

In the context of eSRE development, the standard trait paradigm has the advantages of being applicable to the full age range of interest (i.e., both late childhood and adulthood), and being methodologically consistent with extant adult SRE literature (Symons & Johnston, 1997). The trait eSRE combines the need for children to self-evaluate with their ability to engage in abstract self-reflection within one task. Moreover, the trait eSRE has minimal concrete cues to self-reflection (a generic "Does this describe you?") relative to the desirability eSRE in which stimuli appear alongside the self-face (known to be a very powerful captor of attention; Wojcik et al., 2018). This means that any SRE arising from the trait paradigm in an age-appropriate sample is likely to rely primarily on an elaborative organisation of the material within the self-concept. The aim of Study 3 was to explore whether the stable eSRE pattern emerging from a concrete processing task in Study 2 would be replicated in this more abstract evaluative task. Here, it is not appropriate to include children younger than 8 years, due to their documented difficulties in processing trait adjectives (Damon & Hart, 1988; Eder, 1989; Harter, 1999, 2012; Montmayer & Eisen, 1977).

The trait eSRE task obviates the need to include child-relevant concrete stimuli and makes the inclusion of an adult control sample feasible. Including young adults as an additional comparison group allows us to ensure that any trait eSRE observed is based on mature self-evaluative processes, reflecting a psychologically complex self-concept. Given the stable eSRE found in Study 2 and reported by Pullyblank et al. (1985), we expected adults and 8- to 11-year-old children might show similar magnitudes of SRE in the trait task. Another possibility is that we may witness age related change in the magnitude of the SRE, in line with increases in the volume of autobiographical and semantic self-knowledge held in adulthood relative to childhood.

Method

Participants

A total of 104 participants was included in the sample for Study 3, comprising 38 young adults (13% male, age range = 18-26 years, M_{age} = 19.9 years), along with a sub-set of children from Study 2 who were asked to complete the trait eSRE task in an additional testing session one week after their Study 2 data were collected. A total of 66 children completed this task, comprising twenty-six 8-9 year olds (58% male, age range = 97-119 months, M_{age} = 107.1 months) and forty 10-11 year olds (50% male, age range = 120-143 months, M_{age} = 131.0 months). The children were tested with the written consent of a parent or guardian and their own assent. As in the previous studies, all children had English as a first language and were pupils at local schools. The adults were recruited from the Psychology undergraduate student participant pool and were each reimbursed £5 for their participation.

Materials and Procedure

For the trait eSRE paradigm, 144 trait adjectives were taken from SUBTLEX-UK, a subtitle-based word corpus including the frequency of words appearing on a range of BBC television programmes (Van Heuven et al., 2014). We specifically selected mid to high frequency positive trait words from programming targeting children (Cbeebies and CBBC), and divided them into three equal lists matched for word-length and frequency. Traits from two of the lists (i.e., 96 words) were presented in the encoding phase (one list being paired with self-referent cues and one with other-referent cues), with half of the list items presented above and half below each referent cue. The third list was retained for use as foils in the subsequent memory test. The trait lists were counterbalanced across participants.

For the encoding task, each trial began with a centrally presented question “Does this word describe you?” for self-referent trials or “Does this word describe Harry Potter/Hermione Granger?” for other-referent trials (sex-matched for participant). Participants were asked to indicate whether the trait adjective described the referent (self or other) with which it was presented by means of responding *yes* or *no* via the keyboard, whilst the word was shown on screen. Trials were self-paced, meaning that the participant could take as long as they liked to consider the word and its applicability to the referent. This was necessary since individual children and adults are likely to have very different word processing paces. Following the participant’s response, the question disappeared and a blank 1,000-ms interval preceded presentation of the next trial. Participants completed three practise trials prior to beginning the experimental trials.

Following completion of the encoding phase, a surprise memory test was administered in which traits from all three lists (i.e., two presented in the encoding phase and one previously unseen) were presented in the centre of the computer screen, one at a time. During the test phase participants were asked to indicate whether the trait word onscreen had been presented with a question about themselves, the other referent (Harry/Hermione) or a new word using the keys on the keyboard annotated with “New”, “Me”, “H”. Trials were self-paced. Following completion of the memory test, participants were thanked and debriefed. Scoring was as the e/iSRE task scoring in Studies 1 and 2, with source hit rates corrected for false alarms.

Results

No participants fell outside of three standard deviations above the mean, so all were included in the data analysis. Source memory scores were submitted to a 2 factor (Referent: self, other) mixed model ANOVA with Age as between subjects variable. Source memory was higher for self-referent items (M = .45, SE = .02) relative to other-referent items (M = .33, SE = .02), $F(1, 101) = 103.00$, $p < .001$, partial $\eta^2 = .50$. There was also a main effect of age, $F(2, 101) = 45.84$, $p < .001$, partial $\eta^2 = .48$, with post-hoc Bonferroni tests confirming significant improvement in overall source memory between 8- to 9- years (M = .21, SE = .03) and 10-to 11-years (M = .36, SE = .03; p=.002), and between childhood and adulthood (adult M = .59, SE = .03, both comparisons p <.001). Hits and False Alarm rates are summarised in Table 3.

Table 3

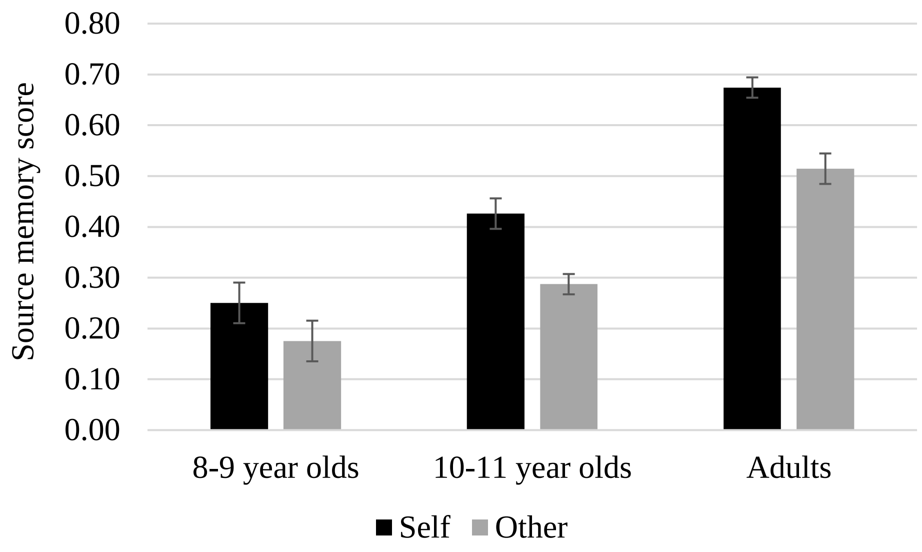
Uncorrected Hit and False Alarm rates by age in the trait SRE task (Study 3).

	Self Referent		Other Referent	
	Hits	FA	Hits	FA
8-9 years	0.51	.26	0.35	.17
10-11 years	0.62	.19	0.43	.14
Adults	0.76	.09	0.66	.15

There was a significant Referent x Age group interaction, $F(2, 101) = 3.82$, $p = .025$, partial $\eta^2 = .07$. Pairwise Bonferroni corrected comparisons revealed that while all age groups showed better memory for self-referent relative to other-referent items, there was a tendency for the magnitude of the effect to increase with age. The magnitude of the eSRE (i.e., advantage for self-referenced traits) was significantly larger in adults ($M_{\text{diff}} = 0.16$, $SE = .02$) than in the 8-9 year olds ($M_{\text{diff}} = 0.08$, $SE = .02$; $p = .024$), but was not reliably different between 8-9 and 10-11 year olds (10-11y.o. $M_{\text{diff}} = 0.14$, $SE = .02$, $p = .124$), nor between 10-11year olds and adults (p= 1.0), see Figure 3.

Figure 3

Source memory scores for Self referent and Other referent items on the trait SRE task, split by Age group (Study 3). (Error bars represent standard error of the mean).



Correlation analysis across the whole sample was not possible because of the discrete adult age range. However, within the age range for which continuous data was available (i.e., 8-11 years; n = 63), there was no significant correlation between age in months and trait eSRE magnitude, $r(63) = .177$, $p = .166$

Discussion

Study 3 aimed to examine whether the stable eSRE pattern found in children aged 8-11 years in Study 2 was replicable with a trait eSRE task. It also afforded the opportunity to include an adult comparison group, for whom the same encoding stimuli could be used. The data showed that there was a relatively stable eSRE within the 8- to 11-year-olds, with no reliable between group differences, and no significant correlation between eSRE magnitude and age in months. However, there was evidence of an element of a gradual developmental increase in eSRE across the whole age group; the youngest children's eSRE magnitude differed significantly from the adults', and the older children's eSRE magnitude was positioned in between the other age groups, but did not differ reliably from either. This pattern suggests that there is scope for eSRE growth after eight years, but this growth may be very gradual, or only apparent when comparing very disparate age ranges.

The data from Study 3 provides evidence to suggest that from late childhood, children's self-processing of abstract traits has similar cognitive consequences as adults. It leads to a large, significant self-referential advantage in memory, which may increase gradually from late childhood to adulthood but does not change reliably across the 8- to 11-year-old period of interest.

General Discussion

The three studies outlined above comprise the first detailed exploration of how encoding information with reference to self differs from encoding relative to other people either incidentally or evaluatively, across development. There are two main findings. The first is that the iSRE emerges early and is age-invariant; we found no evidence of a change in iSRE magnitude across six to eleven years in Study 1, or eight to eleven years in Study 2. The second is that there is an increase in eSRE magnitude with development. Whilst there was no evidence of children younger than eight showing a larger eSRE than iSRE (Study 1), this pattern was strongly evidenced in children aged eight to eleven years (Study 2). Examination of the eSRE in isolation showed that there was no reliable increase within this late childhood period (Study 2, Study 3); however there was evidence of adults showing a larger eSRE than eight to nine year olds, suggesting there is still scope for developmental increases in this capacity beyond eight years.

The current study clarifies that the developmental trajectory for the iSRE is flat across childhood, supporting the findings of previous research (e.g., Cunningham et al., 2014; Dunbar et al., 2016; Maire et al., 2020). We now have four studies measuring the iSRE using the same concrete encoding task that demonstrate an age-invariant pattern from early to late childhood (Study 1, Study 2; Cunningham et al., 2014; Ross et al., 2020). Given the relatively automatic mechanisms proposed to underlie the iSREs, particularly the attentional bias to self-relevant stimuli, this stability is unsurprising (Maire et al., 2020; Turk et al., 2008). What the current findings add to the existing literature is evidence that the iSRE is unchanged in magnitude even up to late childhood, and so is unlikely to be dependent on other aspects of cognitive or social development.

In contrast, the trajectory of the eSRE is upwards, with a shift in the ability to enhance self-referenced information when it is consciously evaluated, at least from about eight years of age. In terms of the shift in pattern from the early childhood eSRE = iSRE to the adult eSRE > iSRE, the current study was unable to determine exactly where the age change happens, because ceiling and floor effects prevented the same task from being delivered across the full age range, and the matched nature of the tasks prevents them from being delivered in a repeated measures design. However, our evidence (Study 2) clearly shows that children of eight years and up demonstrate larger eSREs than iSREs, echoing the pattern reported in adult studies (Turk et al., 2008) and importantly, diverging from the early childhood equivalence (eSRE = iSRE). Future studies might consider longitudinal assessment of the trajectories of the eSRE and iSRE tasks across middle childhood to confirm this result. However, we would caution that because the magnitude of the SRE is constrained by performance, such that the children who perform well overall have less space to demonstrate a strong self-bias, relatively complex individual calibrations of performance would be necessary to observe a neat developmental pattern. Moreover, it would be a potentially unsurmountable challenge to preserve the crucial ‘surprise’ element of the iSRE memory test in a longitudinal design, where the same tests are repeated across different timepoints. A cross-sectional design, such as provided here, may ultimately offer the clearest test of the switch to an adult-like eSRE > iSRE pattern. The pattern of data provide here allows us to confidently approximate the shift to abstract processing at eight years. Post hoc power estimations suggest that our design is powered at 80% to detect the main effects of task type. However, we acknowledge that a larger sample and wider age range may be necessary to observe relatively subtle developmental increments in the magnitude of the eSRE across the lifespan.

There are at least two important cognitive developmental changes that may underpin the growing eSRE that produces this change: a qualitative shift in the self-construct and change in episodic memory capabilities. The switch to an adult-like eSRE > iSRE pattern at eight years fits well with the classic switch from concrete to abstract self-reflection in self-descriptions at eight years (e.g. Eder, 1989; Harter, 1999; Montmayer & Eisen, 1977). Although we cannot directly relate the two developments, our results suggest that rather than being a superficial change associated with vocabulary growth, the switch from concrete to abstract self-reflection may be underpinned by substantive development in the capacity for self-evaluation. We now have three studies (Study 1; Cunningham et al., 2014; Ross et al., 2020) which confirm that children under the age of eight years do not benefit from evaluative self-referencing. In contrast, from eight years onwards (Study 2) children show memory boosts explained by self-evaluative processing. Boosts from self-evaluative processing from eight years have also recently been found in other contexts, with Rowell and Jaswal (2021) showing better source memory for positive action statements associated with the self (e.g. be nice to someone) than negative action statements (e.g. lie to someone) in eight-year-olds.

Relatively little is known about the development of self-evaluation across childhood. Existing evidence suggests that self-evaluative emotions and experiences develop alongside the self-concept in early childhood, from two to four years (see Ross, 2017 for review). However, children younger than eight years may struggle to verbalise or predict self-evaluative experiences (Colonnesi et al., 2010; Ongley & Malti, 2014). Thus, although young children certainly experience self-evaluative emotions, and can take part in ‘self-evaluative’ tasks (as shown in Study 1), it is of interest to track when these experiences and abilities become cognitively bound with the self-concept, and so begin to have mnemonic benefit. Nonetheless, changes in the self-construct happen at a developmental stage that is associated with a raft of emerging cognitive capabilities. In particular, there is an increase in episodic binding that is likely to be critical, since episodic recollection is a hallmark of the SRE (see Conway & Dewhurst, 1995, Andrews et al., 2020), with the self acting as “perceptual glue” that allows new information to be incorporated into our self-representations (Sui & Humphreys, 2017). Developmental improvements in episodic memory are partly attributable to executive and strategic processes, but also partly to enhanced binding of information (Ghetti & Lee, 2011; Raj & Bell, 2010), which directly impacts on episodic recollection of source memory. This means that, for example, familiarity judgements tend to be developmentally stable in Remember-Know paradigms, whereas recollection (requiring bound episodic representation) continues to improve across childhood (Billingsley et al., 2002). In the current study, children were required not only to recognise objects or traits presented at encoding, but also to identify what referent the stimulus was presented with (i.e., source memory). The increasing eSRE is therefore consistent with an increased ability to bind stimuli to the episodic event in which they were encountered, which for self-referenced stimuli includes the memory-boosting activation of stored self-knowledge.

Interestingly, the eSRE task showed no reliable development between eight to ten years in any of the current studies, but there was evidence of a gradual developmental increase between the youngest (8-9 years) and oldest (18-25 years) age groups tested in Study 3. Speculatively, these patterns may reflect the self-development and memory development patterns respectively. The qualitative shift in self-construct that allows for effective reflection after about eight years mirrors the jump in eSRE (over iSRE) that happens at this time and may not significantly change across late childhood. However, as episodic memory systems develop continuously across childhood and adolescence, this is likely to give rise to a gradual increase in eSRE from childhood to adulthood, as self-referenced memories make use of more effective binding of the encoding event and the activated self-knowledge framework.

While the focus of the current work is theoretical, there are significant real-world benefits for understanding when and how the SRE develops. For example, research suggests that the SRE can be applied in education, boosting both task engagement and learning (i.e., retention of information in memory). Turk et al. (2015) found that asking children to practice to-be-learned spelling words in sentences that were self-referent increased both the length of sentence produced (indicating better task engagement) and performance in a later spelling test (indicating better learning), relative to practising using other-referent sentences. Similarly, Cunningham et al. (2018) showed that giving children ‘ownership’ of to-be-learned information increased their subsequent recall of that material. These findings suggest that self-referencing manipulations could be applied successfully in education. Knowing when the benefits of iSRE and eSRE tasks are differentiated provides the opportunity to enhance learning using methods that are targeted appropriately at different stages, maximising educational practices.

Establishing for the first time the developmental trajectory of eSREs and iSREs in typical development also greatly facilitates the interpretation of evidence of changes in SRE elicitation that may be arise in atypical development, such as in autism spectrum disorder (ASD; see Cygan et al., 2014; Gillespie-Smith et al., 2018; Grisdale et al., 2014; Yamamoto & Masumoto, 2018; for contrary perspective see Lind et al., 2020) and attention deficit hyperactivity disorder (ADHD; Klein et al., 2011). The SRE in these developmental disorders is associated with mixed evidence (e.g., see Lind et al., 2020), and this may be at least partly attributable to the fact that researchers have lacked recourse to reliable developmental data from typically-developing children on alternative types of SRE task, a gap in the literature we can now fill. Whether for educational or clinical contexts, it is clear that understanding the developmental trajectory SREs has important applications as well as being of theoretical interest.

Conclusion

The current study provides an overview of eSRE and iSRE development across childhood. A clear conclusion is that the iSRE is age invariant, and while the eSRE is of similar magnitude up to about eight years, after this point it is measurably larger than the iSRE. Although we do not measure underlying mechanisms directly, this period corresponds with a shift in abstract self-representation and self-evaluative emotions, which mature in middle childhood, and with increasing memory capabilities may continue to support increasing eSRE capacity until adulthood. Together, the current studies fill a gap in the literature, explaining how early childhood evaluative and incidental SREs develop into an adult pattern in a manner that neatly fits our understanding of their underlying mechanisms.

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